MANAGEMENT RECOMMENDATIONS

FOR A

MATURE JACK PINE STAND

WITHIN A

KIRTLAND'S WARBLER MANAGEMENT AREA

By

Quentin J. McNichols

Harrisville Ranger District

Huron-Manistee National Forest

February, 1994

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A SILVICULTURAL PRESCRIPTION FOR

STAND 3, COMPARTMENT 189

HARRISVILLE RANGER DISTRICT, HURON-MANISTEE NATIONAL FORESTS

A Term Paper Presented

to the

U.S.D.A. Forest Service, Region 9

In Meeting the Requirements for

the

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and

Silviculturist Certification

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EXECUTIVE SUMMARY

The Huron-Manistee National Forests manage approximately 53,000 acres of jack pine (Pinus banksiana) as critical habitat for the endangered Kirtland's warbler (Dendroica kirtlandii). The Kirtland's warbler is a small bird that nests only in dense young stands of jack pine growing on sandy outwash plains in the lower peninsula of Michigan. Thus, management of the jack pine ecosystem on the Huron-Manistee is critical to the survival of this species.

The ecosystem inhabited by the Kirtland's warbler is among the harshest environments in the state of Michigan. Growing seasons are short, soils are droughty, and precipitation low as compared to the rest of the Huron-Manistee. The Ecological Classification System (ECS) recognized this by classifying these lands as Landtype Association (LTA) 1, Outwash Plains; Ecological Landtype (ELT), Outwash Plains; Ecological Landtype Phase (ELTP) 1, northern pin oak-white oak-Deschampsia plant association. This ELTP is the driest and most nutrient deficient of all the ELTPs. Prior to the advent of fire suppression programs, large catastrophic fires were the predominant means of disturbance, regenerating oak and jack pine and keeping some areas in a semi-open condition. Prior to European settlement many of these areas were probably oak or oak-pine savannas. Current management plans have identified much of this ELTP as critical Kirtland's warbler habitat.

The project area is stand 3 of Compartment 189. While this stand is not currently identified as Kirtlands's Warbler habitat, it is typical of the stands being managed to provide Kirtland's warbler habitat, and it lies within

the Pine River Kirtland's Warbler Management Area (KWMA). It is a mature pole sized stand of jack pine with an oak component. Traditional vegetative management activities would consist of clearcutting followed by machine planting, in an effort to mimic the natural disturbance regime of fire followed by natural regeneration of jack pine. While machine planting has proven to be a highly successful means of regenerating jack pine, it is also far and away the most expensive.

The Huron-Manistee National Forest Land and Resource Management Plan identified the need to develop a silvicultural system of cutting and post-cutting treatments that will produce jack pine regeneration and eliminate the cost of mechanically planting trees.

Seven alternatives are evaluated:

Natural Regeneration	1. Minimum Level Management
	2. Clearcut / Prescribed fire
	3. Clearcut / Rollerchop & scarify
Artificial Regeneration	4. Clearcut / Scarify & broadcast seed
	5. Clearcut / Scarify & direct seed
	6. Clearcut / Scarify & hand plant
	7. Clearcut / Machine plant

There were two criteria used to compare alternatives, regeneration risk and economics. A decision matrix was developed using these criteria. Alternative 5 ranked highest based on these criteria. This alternatives provides the best balance between reforestation costs and the need to insure regeneration of jack pine in Kirtland's warbler habitat.

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INTRODUCTION

Jack Pine and the "Bird of Fire"

The jack pine plains of the northern lower peninsula of Michigan are home to a bird that nests nowhere else in the world. It is in this extreme southern portion of the jack pine range that the Kirtland's warbler (Dendroica kirtlandii) has found it's niche (Figures 1 & 2). This ecosystem is very dry, and burned regularly prior to the advent of fire suppression in the early 1900's. The fires regenerated the dense young stands of jack pine that the Kirtland's warbler depends on for nesting habitat, earning it the name "Bird of Fire". Modern day fire suppression activities have greatly reduced the incidence of fire in this ecosystem. This has created a situation where the Kirtland's warbler is dependant upon human manipulation of the vegetation to produce the required habitat.

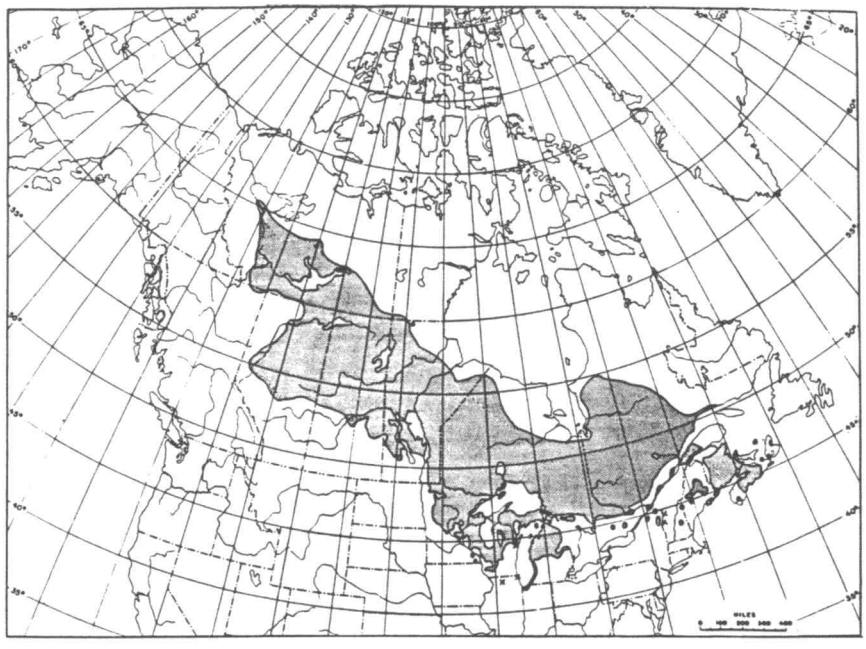
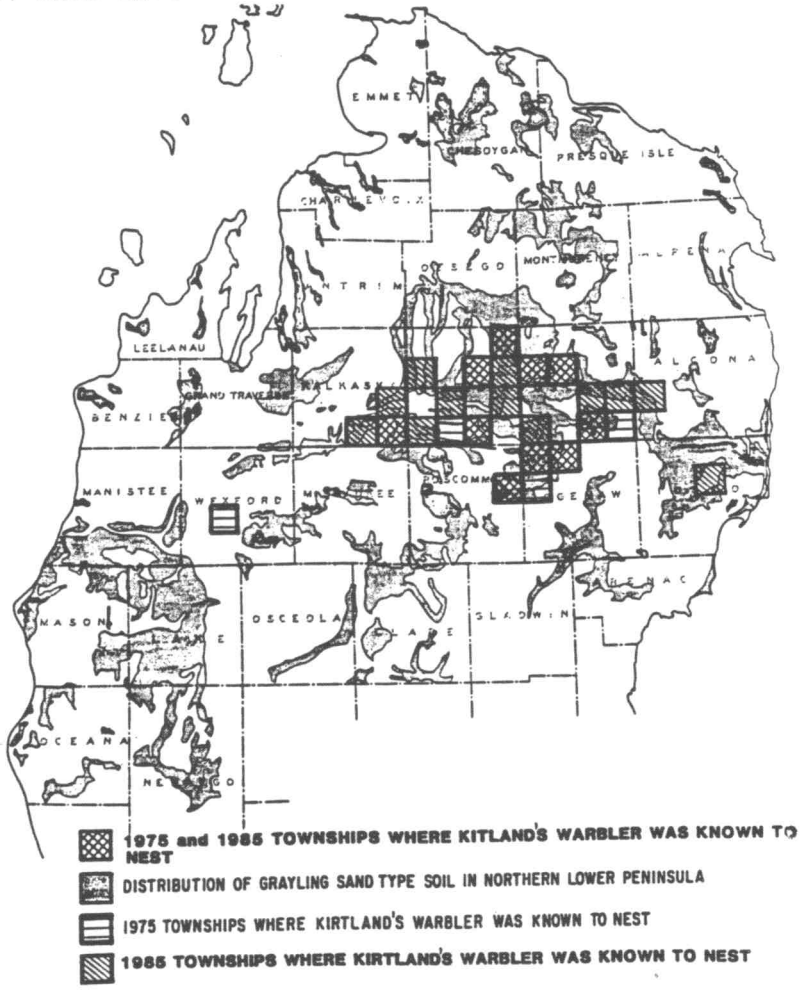


Figure 1. The Range of Jack Pine
Source: USDA 1965

Figure 2. Current Status of Kirtland's Warbler Nesting Range
Source: USDI 1976



Current Management

The Huron-Manistee National Forests manage approximately 53,000 acres of jack pine (Pinus banksiana) as critical habitat for the Kirtland's warbler, which is on the State of Michigan and the Federal endangered species lists. As a federally listed endangered species, management is guided by the Kirtland's Warbler Management and Recovery Plan. The Huron-Manistee National Forests Land and Resource Management Plan further defines the standards and guidelines by which this habitat is managed with Management Prescription Area (MPA) 4.5 - Kirtland's Warbler. The project area lies within the Pine River Opportunity

Area (OA). The Pine River OA is a 28,300 acre block of land that contains 13,800 acres in MPA 4.5. 5400 acres of this is to be regenerated during this management period.

Traditional vegetative management activities have consisted of clearcutting large acreages (up to 370 acres) followed by machine planting, in an effort to mimic the natural disturbance regime of fire naturally regenerating jack pine. While planting has proven to be a highly successful means of regenerating jack pine, it is also far and away the most expensive. In addition, the warblers do not appear to nest in the plantations at the same frequency with which they nest in natural stands. Although, 1993 census results indicate movement into the more recent plantations, possibly as a result of refined planting patterns (Irvine 1993). The combination of these factors, dictate that other silvicultural methods be considered for regenerating jack pine if viable populations of the Kirtland's warbler are to be maintained.

Purpose and Objectives

The purpose of this project is to discuss and evaluate different silvicultural systems for the management of jack pine, and their applicability to management for Kirtland's warbler habitat. Alternatives will be considered for compartment 189, stand 3, with the objective of regenerating the stand to jack pine. While this stand is not currently in Kirtland's warbler habitat, it is adjacent to Kirtland's warbler habitat, and has the same physical characteristics and stand history as most of the stands being managed for habitat. It is hoped that the results of this project will lead to production of desirable Kirtland's warbler habitat at a reduced cost.

BASIC RESOURCES

Soil

The soils of the Huron-Manistee are the result of glacial deposition during the last ice age. The parent materials consist primarily of sand and gravel deposited as moraines, outwash plains, lacustrine deposits, and old shorelines.

Stand 3 occurs on a glacial outwash plain. Soils on these outwash plains are coarse sands often containing less than 3 percent clay and 5 percent silt (USDA 1993). Exposed slopes are easily eroded and slow to revegetate. These soils are dry and infertile, with very low moisture storage. Podzolization results in the soils having very low cation exchange capacity. The soils are typed as Ecological Land Type Phase (ELTP) 1 in the Huron-Manistee Ecological Classification and Inventory System, but are commonly referred to as Grayling Sand. These are the poorest soils on the forest and the most difficult to reforest after harvest. As illustrated in Figure 2, the soil in all known Kirtland's warbler nesting areas is some form of Grayling Sand (Walkinshaw 1983). Additional information regarding ELTP 1 is discussed in the section titled Ecological Classification.

Water

The Huron-Manistee is underlain by aquifers, in the glacial deposits, which feed coldwater streams at relatively constant rates throughout the year (USDA 1986)

The project area drains into McDonald Creek which is part of the much larger Au Sable River Watershed. This eventually drains into Lake Huron at the town of Oscoda, 15 air miles to the southwest of the project site.
The soil is excessively well drained, and becomes very droughty during dry periods, due to the porous nature of the sand and high summertime evapotranspiration rates. The potential for soil erosion due to water movement is very low because of the high percolation rates and lack of topography.

Climate

The climate of the Huron-Manistee National Forests are strongly influenced by the Great Lakes, as is typical of most of the state of Michigan. Temperatures and precipitation vary greatly depending upon proximity to Lakes Michigan and Huron. Prevailing winds from the west pick up moisture from Lake Michigan and deposit it on the Lower Peninsula. Precipitation amounts decrease dramatically as weather systems move eastward across the state. Precipitation from Lake Huron tends to be minor when compared to that from Lake Michigan, due to the prevailing west winds. The exception to this is the occasional "noreaster" that drops moisture in a narrow band, 5-10 miles wide, along the Lake Huron shoreline. The Mio weather station, which is located in the north central portion of the Huron N.F. (Figure 3), reported the lowest total annual precipitation of all reporting stations on the Huron-Manistee National Forests (USDA 1993), indicating the effect of the weather patterns described above.

Temperatures and growing season lengths increase in a north to south gradient, and to a lesser extent in an east to west gradient. The Great Lakes tend to

Weather stations within the interior Huron N.F. and southern Manistee N.F. registered greater temperature fluctuations than the northern Manistee or lacustrine areas. Spring killing frosts occur latest in the growing season in the interior Huron N.F. (USDA 1993).

Stand 3, and all of the KW habitat in the Pine River Opportunity Area, lies in an area that would be considered interior Huron N.F., i.e. the climate is not moderated by the Great Lakes. In addition to this, it is about as far from the Lake Michigan lake effect as is possible in the northern lower peninsula. The result is lower amounts of precipitation, greater temperature fluctuations, and later spring killing frosts than most of the rest of the Huron-Manistee National Forest. The project area lies approximately midway between the Tawas and Mio weather stations.

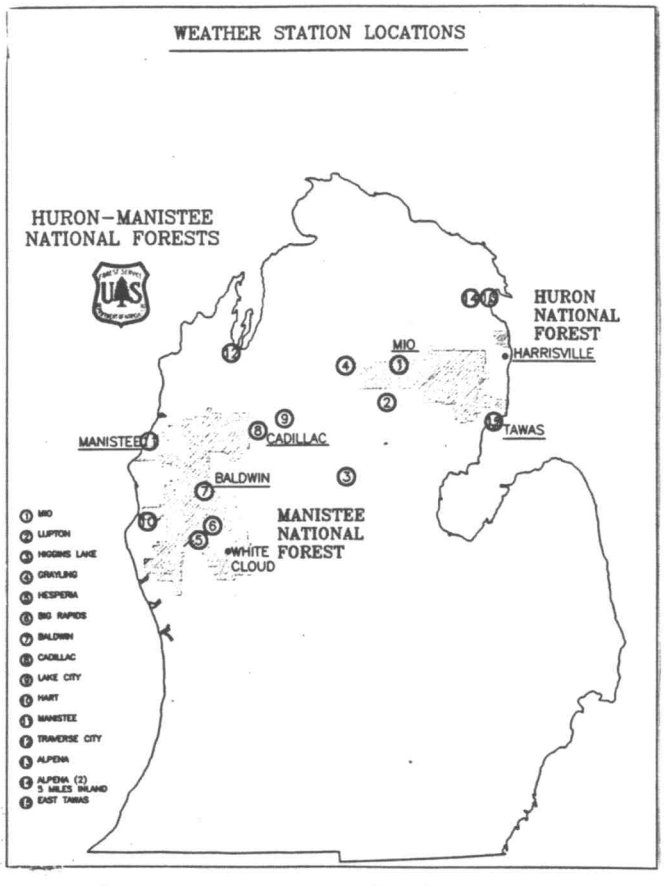


Figure 3. Weather stations on or near the Huron-Manistee National Forests. Source: USDA 1993

Geology and Minerals

The Huron-Manistee is located on the Michigan basin, a sedimentary rock formation (Craul 1991). Glacial drift as much as 1000 feet thick covers the sedimentary rock. The most recent deposition occurred during the last glaciation, which ended approximately 12,000 years ago. (USDA 1986). There are a variety of minerals with potential economic importance. Sand and gravel are the most common and are mined for local uses. Oil and gas exploration and extraction are occurring on Federal, State, and private lands within and around the forest. Gypsum and coal are noncommercial at the present time (USDA 1986).

Stand 3 lies on a glacial outwash plain of deep sand. It was acquired in an exchange with the State of Michigan on March 14, 1930. The state retains rights to all mineral, coal, oil, and gas. There are no records or evidence of exploration or extraction to date.

Ecological Classification

The Huron-Manistee National Forests' Ecological Classification and Inventory System (ECS) Field Guide was completed in 1993. The system is based on a "multifactor ecosystem concept...designed to identify, characterize, and map appropriately sized ecosystems" (USDA 1993). The system integrates climate, landform, soil, and vegetative information and maps them at different hierarchical levels. The Region 9 Ecological Classification and Inventory System framework includes seven hierarchical levels. These range in size from the multi-state level known as the Province, to the Site, which is less than

one acre. The project stand has been mapped and interpreted at the top six levels of the hierarchy as follows:

Hierarchical Level	Classification
Province	1 - Central Lowlands
Section	212H - Northern Great Lakes, Northern Hardwoods-Pine-Spruce-Fir Section
Subsection	m1 - Tawas
Landtype Association (LTA)	1 - Outwash plains
Ecological Landtype (ELT)	Outwash plains
Ecological Landtype (ELTP)	1 - Northern pin oak-white oak-Deschampsia plant association on excessively well-drained sands of outwash plains
Site	Not defined at this time.

For the purpose of most field decisions, the three hierarchical levels that need to be considered are the LTA, ELT, and ELTP.

The outwash plains, LTA 1, were formed by high energy glacial meltwaters which created fairly uniform soil textures and mineralogy (USDA 1993). The soils are excessively well drained sands with poorly developed soil horizons. Moisture and nutrient availability is very low. The resulting natural vegetation consists of species such as jack pine, red pine, and pin oak, which are adapted to these harsh conditions this LTA often exsists across large geographic areas as exhibited in the LTA map of the Pine River KWMA in Appendix E.

The ELT Outwash Plains (OWP) contains four ELTP's which are differentiated primarily by substratum characteristics and stem densities of understory species (USDA 1993). The soils exhibit few morphologic differences, but ELT's closest to the Great Lakes receive more precipitation, and therefore tend to be more calcareous than those further inland (USDA 1993). Landform is generally flat to slightly undulating with most areas having slopes less than 3 percent. The ECS Guide states that "the successional status of ELT OWP is unclear; there is little advanced regeneration of any particular species or advanced regeneration in general" (USDA 1993). While this statement may hold true for the forest as a whole, it does not seem to be the case in the Pine River OA, where oak seedlings and saplings are prevalent in the understory. It is probable that a late successional cover type would consist predominantly of mixed oaks.

ELTP 1 consist of soils that are minimally developed. This is the driest and most nutrient impoverished ELTP. Topography is very flat. It is distinguished from the other ELTP's in this ELT by the presence of the Vaccinium species group as opposed to the Deschampsia group. It is likely that many of these sites were oak-pine savannas or pine barrens prior to European settlement. Natural vegetation was limited to species adapted to a harsh environment and fire related disturbance (USDA 1993).

DEPENDENT RESOURCES

Wildlife

The Huron-Manistee is home to 409 species of vertebrate animals (USDA 1986) including black bear, white-tailed deer, pine marten, ruffed grouse, pileated woodpeckers, and wild turkeys. Three of these species are listed on the Federal Threatened and Endangered Species List. These are the bald eagle, peregrine falcon (transient), and Kirtland's warbler.

As previously mentioned, an important aspect of this project is it's relation to Kirtland's warbler habitat management. Newly regenerated stands of jack pine provide habitat for open grassland and early successional species such as bluebirds, kingbirds, ground squirrels, and Lincoln sparrows (USDA 1986). The jack pine is suitable for Kirtland's warbler habitat from about six to twenty three years of age (Probst 1987). As the canopy closes and the lower branches die off species such as pine warblers and red squirrels move into the stands (USDA 1986). Deer, turkey, and other less habitat specific species are found at all stand ages.

The Kirtland's warbler was first discovered when a spring migrant was taken near Cleveland, Ohio in 1851. It's nesting range was unknown until 1903 when the first nest was found in Oscoda County. Singing males (the females don't sing) and migrants have been found at other locations in the Great Lakes region, but no nests have been found outside of the Lower Peninsula of Michigan (Walkinshaw 1983). The first serious attempt to monitor the population was in

1951. At that time, 432 males were found and the population was estimated to be roughly double that, based on the assumption that there was an equal number of females. A repeat census in 1961 found 502 males, indicating a stable population. The third census, in 1971, showed a decline to 201 singing males (Walkinshaw 1983), as the population collapsed back into the center of it's range (USDI 1976). After 1971 the census was taken annually. Counts remained stable until 1987, when an increase began (Figure 4) due to the coming on line of over 11,000 acres of habitat that resulted from the Mack Lake Fire of 1980. The 1993 census found 485 singing males, 343 on Huron National Forest lands,which are identified as NFSL in the graph below (Irvine 1993).

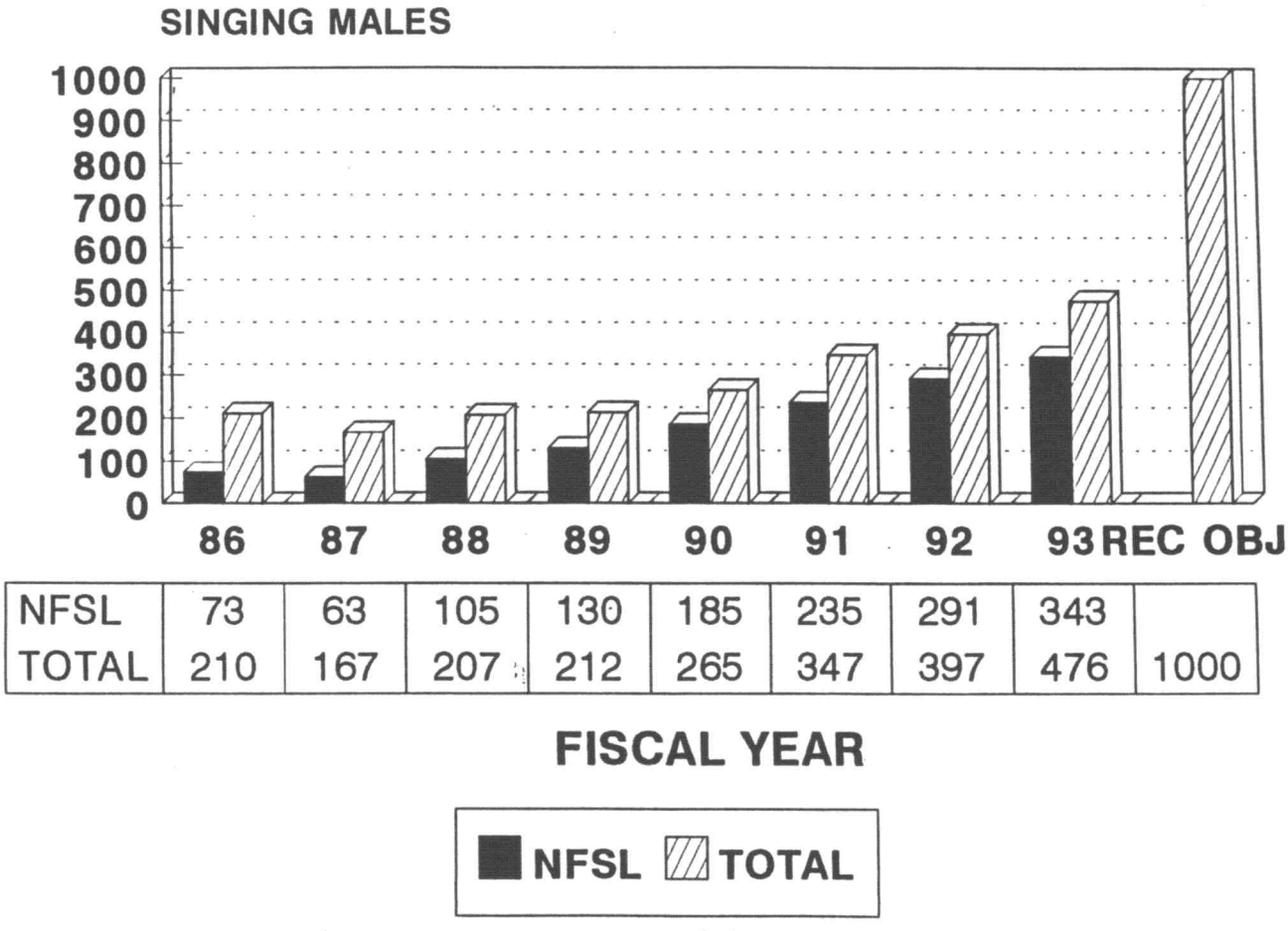


Figure 4. Kirtland's Warbler Census Results 1986 - 1993
Source: Irvine 1993

This increase is not expected to hold unless more habitat is created to replace the Mack Lake fire area, which will grow out of habitat in the next five to ten years. The importance of the Mack Lake KWMA to the current Kirtland's warbler population cannot be overstated (Figure 5), because it contains 84% of all the Kirtland's warbler's censused on the Huron National Forest. Without another catastrophic fire to create vast acreages of jack pine regeneration, the Pine River KWMA will become increasingly important as replacement habitat for the Mack Lake KWMA. This shift in the Kirtland's warbler population from Mack Lake to Pine River and other KWMA's, is already in it's early stages and will continue until approximately the year 2000. At that time the Mack Lake KWMA will contain relatively little desirable Kirtland's warbler habitat.

Kirtland's Warbler Management Areas
Huron National Forest

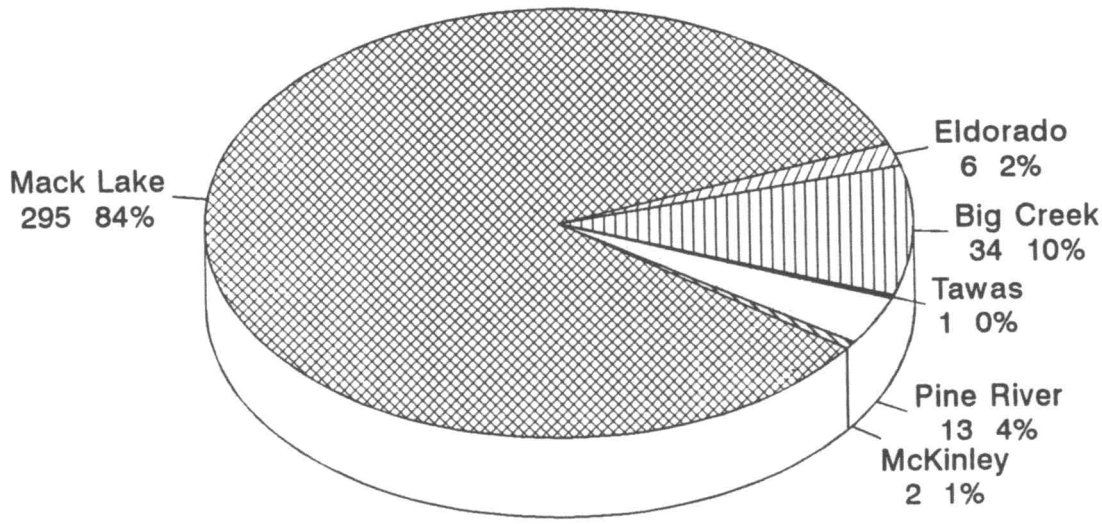


Figure 5. Number of Kirtland's Warbler Singing Males Censused, by KWMA.
Source: Irvine 1993

The Kirtland's warbler has probably never been very numerous due to it's narrow habitat requirements. The bird is known only to nest in dense stands of young jack pine growing on sandy outwash plains. This zone is a fairly narrow strip across the north central states, so even under optimum conditions the total amount of habitat would not be great (USDI 1976).

In addition to limited availability of habitat, the reproductive success of Kirtland's warbler's is significantly reduced by parasitism of the Brown-headed Cowbirds. Cowbirds lay their eggs in warbler nests. Due to their larger size and shorter incubation periods, the cowbird hatchlings easily outcompete the warblers for food. Trapping and destruction of cowbirds is done in conjunction with vegetative management for jack pine.

Recovery efforts for the Kirtland's warbler are overseen by the Kirtland's Warbler Recovery Team. This team is selected by the Secretary of the Interior to guide the U.S. Fish and Wildlife Service in carrying out provisions of the Endangered Species Act of 1973 (USDI 1976). The major agencies involved in this effort are the U.S. Fish and Wildlife Service, U.S. Forest Service, and the Michigan Department of Natural Resources. The Michigan Chapter of the National Audubon Society is also very active and supportive of the Kirtland's warbler program.

The project area is within Pine River KWMA, Unit III (Appendix C). Stand 3 is approximately one half mile from essential Kirtland's warbler habitat.

Fisheries

The Huron-Manistee contains warm water, cold water, and anadromous fisheries. The warm water fisheries contain largemouth bass, bluegill, and pumpkinseed sunfish. The cold water fisheries have native populations of brook, brown, or rainbow trout. Anadromous fisheries are the free-flowing rivers and streams which flow into Lakes Michigan and Huron. These have populations of steelhead, brown trout, and chinook and coho salmon (USDA 1986).

The closest water body to the project area is the south branch of McDonald Creek (Appendix B). This is a high quality cold water fishery containing brook trout and sculpins. Fishing pressure is very light. There is expected to be no impacts upon this stream from the proposed project (Gardner 1993).

Range

There is little potential for grazing in stand 3, due to low soil fertility and lack of water. These types of sites are the poorest sites on the forest, and probably in the state, with regards to agricultural potential. Grazing is not permitted in areas identified as essential Kirtland's warbler habitat (USDA 1986).

Fire

Fire is the primary and dominant mode of natural disturbance in the jack pine ecosystem in Michigan. The frequent fires and xeric conditions of LTA 1 favor species such as jack pine, red pine, and northern pin oak (USDA 1993).

Vegetation on the outwash plains has been influenced more by fire and human fire control activities than any other disturbance factor. Fires that occur burn large areas in a short period of time. An excellent example of this is the previously mentioned Mack Lake Fire, which burned over 20,000 acres, most of it the first day of the fire. Prior to European settlement, fire was the primary means by which jack pine and oak were regenerated. The serotinous cones of jack pine are opened by fire, releasing seed on the newly exposed mineral soil. The stumps of the dead oak sprouted after the fires. Post settlement fire control activities have resulted in large acreages of overmature jack pine and oak. Clearcutting and planting have taken the place of fire in regenerating the jack pine. Oak still regenerates well as the result of stump sprouts after cutting.

The Forest Plan identifies the need for research to determine how fire affects the Kirtland's warbler's nesting habitat requirements. While the warbler's are found in stands that have not been burned, evidence indicates they prefer stands that have been burned (USDA 1986). The roll that fire plays in establishing vegetative communities needs to be better understood.

Recreation

Recreation activities in the Pine River OA consist primarily of dispersed type activities. These include hunting, riding snowmobiles and ORV's, blueberry picking, wildlife viewing, trapping, and dispersed camping. The road adjacent to stand 3, FR 4304 (Appendix F), serves as an east-west through road, receiving moderate use in the snow free season. In the winter it is not plowed

and is used by snowmobilers. There is one developed recreation area, the Pine River Campground, which is approximately 4 miles west of the project area. The Recreation Opportunity Spectrum (ROS) classification for this OA is Roaded Natural (USDA 1986).

Recreation opportunities provide for dispersed recreational activities must be consistent with management of essential Kirtland's warbler habitat. Trails are managed to avoid use during the nesting season and no new trails are to be constructed.

Visuals

Visual resources are defined in terms of Sensitivity Levels and Variety Classes. A Sensitivity Level is a measure of the publics concern for the appearance of the landscape. Variety Class is a measure of diversity or inherent natural beauty as it relates to what the variety could be. These inventories are combined to create Visual Quality Objectives (VQO).

Stand 3 has a Variety Class B, common, and a Sensitivity Level 3, least sensitive. This gives it a VQO of maximum modification. Most areas that are in and around Kirtland's warbler habitat have VQO's of modification or maximum modification.

The Forest Plan recognized that it is difficult to meet visual management objectives and maintain Kirtland's warbler habitat. This is due to the large size of the clearcuts and the lack of vegetative diversity in these areas. This continues to be a difficult dilemma to resolve, and is best solved on a

case-by-case basis. Mitigation measures commonly used to reduce the visual impacts include retaining large scattered red pine or patches of oak. In any case, it is difficult to make a 300 acre clearcut aesthetically pleasing.

Cultural Resources

The earliest known archeological sites on the Huron-Manistee National Forests date back to the end of the last Ice Age, which was approximately 12,000 years ago. When the Europeans arrived in the 1600's the area was inhabited by Algonquin speaking natives collectively referred to as the Ottawa. The first settlers came to Michigan in the early 1800's, and the logging industry dominated the states economy from the mid-1860's until 1900 (USDA 1986). By 1900 most of the original forest had been logged off, and the timber companies moved west in search of more timber.

A cultural resource survey was performed on the project area in July, 1992. No sites were found, and there is only one known site within a mile of the project area. This area is considered low sensitivity as far as locating any cultural resources is concerned.

TIMBER

Management Systems

Jack pine is a relatively short lived species which regenerates itself naturally following a fire. It is a primary successional species which is shade intolerant, thus limiting silvicultural systems to even-age management systems. There are three systems recognized as practical for managing jack pine: seed tree, shelterwood, or clearcutting (Benzie 1977).

The seed tree system is recommended for high quality stands (Rudolph 1983) growing on good sites (Erickson, Hacker, and Marshall 1981). Prescribed burning is needed to reduce slash, reduce competition, expose mineral soil, and open the cones to release the seed (Benzie 1977). The advantage to this system is that genetic gain can be realized from generation to generation because the best trees are selected for seed trees (Rudolph 1983). A hot fire is critical to destroy the seed from undesirable trees that may be left on site after logging.

The shelterwood system is useful in vigorous stands that have trees with non-serotinous cones making up at least 8 sq.ft. of basal area per acre (Caveney and Rudolph 1970). The 3-cut shelterwood method is believed to be more desirable than the 2-cut method because the environment is good for establishment at two different times prior to the removal cut, and seedlings established after the first cut would be released during the second cutting (Caveney and Rudolph 1970). There are several disadvantages of the shelterwood

system: there must be enough initial stocking to carry three commercial timber sales; stands with a mixture of species may convert to more shade tolerant, longer lived species; control over stocking is difficult; and regeneration will take longer to attain than with the seed tree or clearcutting method (Rudolph 1983).

The clearcutting system is the most commonly used method in the Lake States. Regeneration can be attained by a number of different methods including seeding, planting seedlings, or scattering cone bearing slash. All three regeneration methods have been successful to some degree, but only planting of seedlings has consistently produced the results desired for creation of Kirtland's warbler habitat. Additional discussion of reforestation methods is included in the Regeneration section of this paper.

Rotation ages for jack pine range from 40 to 70 years (Benzie 1977). The Forest Plan for the Huron-Manistee N.F. recommends stands be harvested at 40-45 years of age, however this has proven impractical due to the poor market conditions that existed in the 1970's and early 1980's. The result is that over half of the jack pine and jack pine/oak stands in the Pine River OA are over 50 years of age. In this condition the stands are more susceptible to insect and disease outbreaks, and are at increased risk of catastrophic wildfires.

The current vegetative management strategy for jack pine in Kirtland's warbler habitat is to manage stands on a 50 year rotation with clearcutting followed by slash removal and machine planting. The areas cut can be as large as 370 acres, but are generally in the 200-270 acre range. Most sites are whole tree

harvested, but where whole tree harvesting is not used, burning is the preferred method of slash removal. Machine planting is then done to ensure adequate regeneration of jack pine. The objective is to artificially mimic the results of the catastrophic fires which historically produced the habitat required by the Kirtland's warblers.

Stand Structure

Stand 3 is of natural origin, probably fire, that originating in approximately 1920. There is no history or evidence of cultural treatments in the stand. Current stocking is 76 square feet of basal area per acre in jack pine and mixed oak. The break out is 20 sq. ft. in sawlog sized trees, 50 sq.ft. in poletimber sized trees, and 6 sq. ft. in saplings. An average of 14 sq. ft./ acre is in oak species, the other 62 sq. ft./acre is jack pine. Tree heights for dominant and codominant jack pine were in the 54 to 63 foot range. Heights for northern pin oak averaged approximately 40 feet. A summary of the stand conditions in 1993 is shown in Table 1.

Stand Characteristics	VMIS Code	Remarks
Acres	20	
Site Index (JP)	48	
Yr. of Origin	1920	
Type/Size Density	016	JP poles >70% stocked
Total Basal Area	76	
Stand Condition	4	Mature w/ high risk

Table 1. Stand Summary for Stand 3, Compartment 189

This summary is based on data from five plots taken using standard silvicultural examination procedures as described in Chapter 200 of the Compartment Prescription Handbook, FSH 2409.21d. Actual plot data is shown on the Stand Tally Sheet in Appendix G. These characteristics are typical of those stands being harvested and managed for Kirtland's warbler habitat in the Pine River OA.

Growth and Yield

The December 1987 Lake States Version 3.0, of The Woodsman's Ideal Growth projection System (TWIGS) was used to project growth and yield for the project stand. The total estimated volume for all species in pulpwood and sawtimber is 1010 cubic feet of growing stock per acre, broken out as shown in Table 2. The mean annual increment (MAI) for the stand was 13.8 cu.ft / yr. Board foot volumes are in International 1/4 inch rule. For comparison purposes, it is interesting to note that the cruise volume calculated by the USDA Forest Service Automated Cruise Data System ware 5.75 cords and 550 board feet per acre of jack pine for the East Bud Jack Pine Salvage Sale. This discrepancy is likely attributable to differences in the type of data collected (tree heights were recorded for the sale cruise) and averaging with other payment units in the timber sale.

	Sawtimber		Pulpwood		Growing stock	Residue	
Species gr.	cuft	bdft	cuft	cords	cuft	cuft	tons
JACK PINE	256	1559	574	7.3	830	548	13.1
O.RED OAK	0	0	180	2.3	180	133	4.1
Stand totals	256	1559	754	9.5	1010	681	17.2

Table 2. Stand Volume for 1993 as generated by TWIGS

Whole tree harvesting is the commonly used method of logging jack pine stands in Kirtland's warbler areas. The large size of the cuts and the relatively low volumes per acre favor those operations over the traditional shortwood operations. In fact, according to the TWIGS analysis of current stand conditions, whole tree harvesting yields an additional 681 cu. ft. in residue. This was not given a value in the TWIGS economic analysis, due to the lack of evidence that there is any increase in bidding on sales that are cut by whole tree operators as opposed to shortwood operators.

Insect and Disease

Jack pine is generally a very hardy species that thrives on sites that are too harsh for other species. This hardiness also exhibits itself as tolerance or lack of susceptibility to insects and disease. While there are a number of insect and diseases that can affect jack pine, there is usually little affect on a stand unless there are contributing stress factors such as overstocking, overmaturity, or drought.

Diseases which can have an economic impact include pine-oak rust (Cronartium quercuum), pine-pine rust (Endocronartium harknessii), and red heart (Phellinus (Fomes) pini). The gall rusts are considered the most serious diseases and are found throughout the Lake States (USDA 1981). Other diseases tend to only be of significance when they occur in conjunction with other stress factors (Robbins 1984).

A variety of insects are associated with jack pine. Species of insect and severity of effects varies with age and stand condition of the jack pine.

Benjamin developed a list of economically important insects associated with jack pine in Wisconsin. This list is shown in Appendix I, and is applicable also to jack pine in lower Michigan.

The most significant risk to jack pine on the Huron N. F. comes from jack pine budworm. The budworm feeds first on the flower cones and new needles and later consumes all the foliage (USDA 1979). This insect is always present, but reaches outbreak populations on a cycle of approximately ten years. The most recent outbreak occurred in 1991. At that time a large area was affected due to the large acreages in an overmature condition. Outbreak conditions generally last two to four years, however this outbreak only lasted one year. The likely reason for this was a heavy frost in early June of 1992, which occurred at a time when the insects were at a susceptible stage of development (Ingram 1994).

Stand 3 was heavily defoliated in the summer of 1991, and was sold as part of the East Bud Jack Pine Salvage Sale in March 1993. Due to the early collapse of the budworm population, mortality was not as severe as originally anticipated, but was still roughly 10%. The stand remains high risk, with a risk factor of 15, according to the Jack Pine Budworm Hazard Guide developed by Ford (Appendix J). If left uncut the stand would likely suffer increasingly higher mortality in each successive outbreak of budworm.

The presence of oak in stand 3 brings into play several disease that also affect jack pine. Pine-oak rust infects oak leaves in the late spring and spreads to jack pine during the summer, requiring oak as an alternate host to complete it's life cycle. Shoestring root rot (Armillariella mellea) spores

germinate on dead wood and the fungus becomes a wood decayer. Live trees can be infected when they come in contact with decaying wood or the rhizomorphs. Young pine planted in areas from which hardwoods were cut are particularly susceptible (USDA 1979).

Gypsy moth, (Lymantria dispar) is an introduced insect that has had a significant impact on the oak resource in Michigan. While gypsy moth has been present on the forest and in stand 3 for several years, it has not had a significant impact on the oak because of the mixed nature of the stand. Gypsy moth does not defoliate jack pine. Therefore it is not seen as a negative factor in managing this stand. In fact, it may be beneficial from the standpoint of Kirtland's warbler habitat, because it could decrease the percentage of oak in the stand.

In general, the best management for this stand, and similar stands growing on the outwash sand plains, is to maintain the stands in a well stocked, vigorous condition, regenerating them before they become overmature. This will greatly reduce the likelihood of significant losses from insects and disease.

Herbicides

Jack pine seedlings and saplings do not survive or grow well under conditions of partial shade or intense competition from grasses and sedges. Therefore release from competing vegetation is necessary when it is present. This situation arises when jack pine is regenerated along with deciduous species or in areas with inadequate mechanical site preparation. In each of these cases mechanical means of release are available, such as hand felling residuals or

scalping around seedlings. However, these methods are very labor intensive, and quickly become cost prohibitive if large acreages or large numbers of stems/acre are involved. When this is the case herbicides are more efficient and economical to use. The herbicides most commmonly used to release jack pine are 2,4-D and 2,4,5-T.

Herbicides were not considered as an option for site preparation on this stand. There are several reasons for this. First, the competition from other vegetation is not great. Most of the competition would be from grasses and oak stump sprouts. The oak densities prior to cutting are low enough that significant competition is not expected. The grasses will take several years to fill-in following the mechanical site preparation methods described in the alternatives. Second, in KWMA's, herbicides can only be used after consultation and coordination with the Kirtland's Warbler Recovery Team. At present, the teams philosophy is that pesticides should not be used in KWMA's due to the unknown effects on non-target species that may be important to the Kirtland's warbler (Huber 1993). Finally, in March of 1990 the Forest Supervisors of the seven National Forests encompassing the Lake States decided that no herbicide use would be permissible under an Environmental Assessment (EA). Additionally, due to concerns over the time and money involved in preparing an Environmental Impact Statement (EIS), they decided to discontinue preparation of an EIS that proposed the use of herbicides on national forests in Wisconsin, Michigan, and Minnesota (Appendix Q).

Intermediate Treatments

Intermediate treatments may be necessary in stands that are overstocked. Treatments appropriate for jack pine are weeding, cleaning, and thinning. Weeding takes place during the seedling stage and cleaning during the sapling stage. Both are done to provide more growing space for a selected number of potential crop trees. These are usually done precommercially as there is no market value for this small sized material. Commercial thinnings are appropriate on better sites (SI 60+) where the management objective is production of poles and small sawlogs (Benzie 1983). Basal area should be reduced to 80 sq. ft./acre to maximize growth of the crop trees. On poorer sites and in stands not being managed for poles and sawtimber, thinnings are not recommended (Benzie 1977).

Stand 3 and most stands being managed for Kirtland's warbler are on poor sites, managed only for pulpwood. The Kirtland's warbler requires well stocked (1250+ trees/acre) stands of jack pine saplings. Therefore, weeding and cleaning at less than twenty years of age would be counterproductive in stands managed for Kirtland's warbler habitat. Commercial thinnings to produce poles or sawtimber are not done because of the poor site productivity and the short rotations.

Harvesting System

The two commonly used harvesting systems on the Huron N.F. are shortwood and whole-tree operations. Shortwood operations, where the trees are cut into product length material (generally 100") in the woods and then skidded to the

landing, are generally used in thinnings and selection cuts. Whole tree chipping is the method used in clearcuts and some pine thinnings.

The large clearcuts in Kirtland's warbler habitat are ideal for use of whole tree harvesting. Currently, all Kirtland's warbler clearcuts are whole tree harvested. There is some concern that whole tree harvesting may adversely impact site productivity on poor soils, especially Grayling sands. E.H. White states that "whole tree harvesting would aggravate existing potassium and magnesium deficiencies on coarse textured outwash sands" (White 1991).

The Forest Plan for the Huron-Manistee National Forests identified whole tree harvesting and its' long term impacts on soil productivity as an area needing further research. The North Central Forest Experiment Station in cooperation with the Huron-Manistee, is currently doing a study to determine the effects of whole tree harvesting on aspen sites. Additional research needs are identified for nutrient poor sands, especially Grayling sands, on outwash plains.

Another concern is that whole tree harvesting removes the woody debris that provides feeding sites for the Kirtland's warbler. Harvesting prescriptions have been modified to retain all dead or downed trees in order to provide these feeding sites.

Market/Utilization

The current markets on the Huron N.F. are stable or improving for all species and products. Some increase in sawtimber prices are occurring as the result of reduced sawtimber production in other parts of the country. This trend is

expected to continue. There are a number of sawmills in the northern lower peninsula that utilize sawtimber products from the Huron N.F. Pulpwood sized material goes to a number of mills also, most notably Weyerhauser in Grayling, and Abitibi-Price Corporation in Alpena.

Most of the jack pine harvested in the Pine River OA is sold as chips to the Viking Energy electric cogeneration plant in Lincoln. The East Bud Jack Pine Salvage Sale was purchased by Inman Forest Products of Glennie, Michigan. The jack pine is being hauled to Viking Energy and the oak is being used for firewood by homeowners.

Regeneration

Regeneration of jack pine has been and continues to be a very important issue on the Huron N.F. for two reasons: it is critical to the survival of the Kirtland's warbler, and current practices are becoming cost prohibitive. The Forest Plan recognized the need to "develop a silvicultural system of cutting and post-cutting treatments for jack pine that will produce natural regeneration in consistent densities for Kirtland's warbler". The objective being to "reduce or eliminate the costs of mechanically planting the trees". A number of different treatments have been attempted over the years. These treatments did not consistently achieve fully successful results and were thus abandoned for the proven method of planting trees. In light of continued budget tightening, a second look at some of these silvicultural treatments and the factors affecting regeneration, is in order.

Factors Affecting Regeneration

Success in regeneration of jack pine is dependent upon a number of factors as listed below (USDA 1979):

1) Adequate seed source or seedlings
2) Suitable seedbed preparation
3) Temperature - both soil and air
4) Precipitation - amount and distribution throughout the growing season
5) Soil fertility
6) Competing vegetation

Of the six factors listed, all except precipitation can be controlled or modified to some degree as described below:

Seed source - planting seedlings is the most direct way to insure stand establishment. When not planting seedlings, adequate seed can be supplied by either leaving conebearing slash on the site or by direct seeding. Recommendations vary on the amount of seed to apply, ranging from 3 ounces (20,000 seeds) per acre (Benzie 1977) to 8 ounces per acre on dry sites (Erickson, Hacker, and Marshall 1981).

Seedbed preparation - Site preparation for seeding (either natural or artificial) should attempt to expose mineral soil. The objective is a minimum of 60% exposed mineral soil (Erickson, Hacker, and Marshall 1981) whether broadcast seeding or relying on natural seed sources. Fire has been used to accomplish this, however fires that are hot enough to adequately prepare a seedbed are also hot enough to destroy most of the

seed in the slash (Erickson, Hacker, and Marshall 1981). When direct seeding or planting seedlings, a patch or furrow should be scalped to expose the soil. This scalp should be a minimum of 18 inches square to completely remove sod competition in addition to exposing mineral soil.

Temperature - The temperature at the air/soil interface has a significant effect on transpiration rates and therefore survival of young seedlings. Seedlings less than three months old are very susceptible to damage from drought and heat (Erickson, Hacker, and Marshall 1981). Logging methods which leave some slash, and site preparation which creates an uneven surface, will raise the active surface of the site, creating a cooler and less windy microclimate resulting in less evapotranspiration.

Soil fertility - Can be favorably impacted by fertilizing or more simply by leaving logging tops and slash scattered across the site. Stirring organic matter releases nitrogen and other nutrients for the short term, one to two years (Craul 1991). This would help in the early years of seedling establishment, and could be accomplished with a disc or rolling chopper and anchor chains.

Competing vegetation - Grasses and sedges will compete strongly for water and soil nutrients. Removal or reduction of direct competition from these is critical, whether planting or seeding. The sod must be set back enough to allow seedlings three to five years to develop without significant competition. V-plows used during machine planting, and scarifiers such as the Bracke used prior to hand planting, are very effective in reducing competition.

With regards to regeneration methods other than planting, adequate seed supply and good mineral soil exposure can be critical. Studies done on Grayling sands in Michigan, indicate that scarification and direct seeding greatly increased the likelihood of successful regeneration (Cooley 1972).

Past Silvicultural Practices

Depending on the condition of the site after logging and specific site factors, a number of different post logging treatments have been used to regenerate jack pine in the Lake States. The following is not meant to be an all inclusive list, but a list of practices which show merit based on consideration of the factors affecting regeneration listed above. This information is based upon years of experience accumulated by foresters working for a variety of agencies, most notably the Michigan Department of Natural Resources (MDNR), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Forest Service (USFS). Field visits and conversations with individuals from these agencies, a search of existing literature, and personal experience have all gone into making up the following descriptions. All of these practices could be used following clearcutting. They are divided into the general categories of Natural and Artificial regeneration, although they are all artificial in so far as they are implemented by humans.

Natural Regeneration

These methods require that slash is left scattered across the site. Timing is very important in both cases, in order to get the site prepared prior to seed release and germination.

Broadcast burning - Reduces fire hazard and releases seed. May prepare seedbed and remove competition under the right conditions. However, several studies have suggested that this is not an effective regeneration method for clearcut sites. A fire that is hot enough to prepare an adequate seedbed also destroys most of the seed in the slash (Erickson, Hacker, and Marshall 1981). Other negatives are the narrow windows within which to burn, and the potentially high financial and social impacts of an escaped fire. The biggest benefit of burning is that it is generally the least expensive method.

Slash treatment and mechanical scarification - Slash treatment is usually accomplished with a drum rolling chopper. The roller chopping reduces the fire hazard and reduces the height of the slash to within one foot of the soil surface, ensuring more rapid and certain cone opening. In areas of particularly heavy slash accumulations two passes may be necessary. If these passes are perpendicular to one another scarification is greatly improved. Scarification can then be accomplished with tools such as a disk harrow, anchor chains, or root rakes. Whichever is chosen, the objective is to expose mineral soil on at least 60 % of the area to prepare an adequate seedbed. This method should be carried out early in the spring or

late in the fall to permit germination to occur during conditions most favorable to seedling survival.

Artificial Regeneration

Seeding - This can be accomplished by a number of different techniques. Spot seeding, broadcast seeding, and drilling have all been used with some degree of success. Spot seeding can be accomplished in patches prepared by equipment such as a bracke scarifier which has a seeding mechanism, or in furrows created by equipment such as a V-plow or disc trencher. Broadcast seeding, which has generally been more successful than spot seeding (Erickson, Hacker, and Marshall 1981), can be done on foot or smowmobile, or from aircraft. This author recently broadcast seeded an area on cross country skis, accomplishing over 15 acres in less than 5 hours. In any case, seedbed preparation for broadcast seeding must be the same as that for natural regeneration techniques. Seed spread on improperly prepared areas generally results in regeneration failure (Erickson, Hacker, and Marshall 1981) and it is believed by this author that the lack of adequate seedbed preparation is the single most common reason for seeding failures. Another method that has been used successfully by the MDNR, and to some degree by the Huron N.F., is the use of a modified corn planter pulled behind a small crawler tractor (Botti 1984). The MDNR is currently working with the recently developed TTS Sigma row seeder, apparently with better success than with the modified corn planter (Ennis 1993). Recommendations for the amount of seed to apply vary from three ounces per to eight ounces per acre on dry sites. Considering the climatic conditions and poor soils, any broadcast seeding in Kirtland's warbler habitat should apply at least 8

ounces per acre. The modified corn planter uses approximately three ounces per acre on better sites, more would be applied on Kirtland's warbler sites.

Planting - Hand - Site preparation for hand planting is usually done with a bracke scarifier or disc trencher. It can also be done by hand scalping or a V-plow, although these methods are more expensive. A variety of crews have been used for tree planting in the Lake States, best results are achieved with contract crews of professional tree planters. Prison crews, welfare crews, and similar work crews are inexpensive but generally are difficult to motivate and often do careless work.

Planting - Machine - Machine planting is the current preferred method of regenerating jack pine in Kirtland's warbler habitat. It is at present the most dependable method of regenerating jack pine to the densities required for Kirtland's warbler. Trees are planted on a 5' x 6' spacing to achieve 1452 trees per planted acre. A Whitfield Forest Transplanter is pulled behind a John Deere 450 tractor with a V -plow on the front for scarification. Planting is done in a wavelike pattern (Appendix P) to create the small openings required in Kirtland's warbler habitat.

Tree Improvement

Jack pine exhibits considerable genetic variability and significant yield gains can be achieved through genetic improvement programs. Improvements are made in two ways, first by selecting a good seed source and second by selective breeding within breeding populations. Large initial gains can be made through

seed source selection, and greater gains are possible through recurrent selection within populations. Yield gains of 5% each generation are expected (Reimenschneider 1984).

A number of tree qualities can be affected by seed source including growth and yield, form, survival, and number of branches. Geographic trends have been noted in jack pine relating to several qualities. In general, seed from southern sources produce faster growing seedlings which are less susceptible to late frosts, more susceptible to winter injury, have weaker seed dormancy mechanisms, and bear a higher percentage of non-serotinous cones (Erickson, Hacker, and Marshall 1981). However, it should be noted that climatic zones, and thus seed zones, are affected by the Great Lakes and therefore are not clearly delineated on a latitudinal basis (Reimenschneider 1984).

Genetically superior jack pine seedlings are available from the USFS nursery in Watersmeet, Michigan. Some are being outplanted on the Huron-Manistee. The paradox in planting superior jack pine in Kirtland's warbler habitat is that a number of the qualities normally selected for are not beneficial from the Kirtland's warbler standpoint, and in fact may be detrimental. For example, branchiness is generally considered undesirable from a tree improvement standpoint, and in fact, number of branches is a quality that can be affected by seed source. However, the Kirtland's warbler nests on the ground, under the low hanging branches of jack pine saplings. Selecting seed sources or superior trees with less branches could remove a critical element of the Kirtland's warbler's nesting requirements. An "improved" jack pine for Kirtland's warbler planting would have high survival rates, slow growth in the sapling phase, and numerous low hanging branches.

LAND MANAGEMENT PLANNING

Forest Plan

The Huron-Manistee National Forests Land and Resource Management Plan (Forest Plan) was approved on July 16, 1986. The Forest Plan divided the forest into Management Prescription Areas stating desired future condition (DFC), management direction, and standards and guidelines for achieving the DFC.

The project area lies within Management Area (MA) 4.5 - Kirtland's Warbler. Management activities in this MA are to "maintain and develop essential nesting habitat for the Kirtland's warbler in compliance with the provisions of section 7 of the Endangered Species Act (P.L. 93-205) and as outlined in the Kirtland's Warbler Management and Recovery Plan." Additional goods and services include production of softwood and hardwood pulpwood and sawtimber, opportunities for dispersed recreation such as hunting and camping, and providing opportunities for mineral exploration and development (USDA 1986).

The Pine River OA Analysis was completed in October of 1988. The OA contains approximately 28,300 acres, 13,800 acres is in MPA 4.5. The OA analysis proposed management activities which included recreation, wildlife, fisheries, and timber activities. Included in these was a proposal to regenerate approximately 5400 acres to jack pine for Kirtland's warbler habitat. This proposal was tiered to the Kirtland's Warbler Management and Recovery Plan, and the Forest Plan.

Alternatives

Process Used to Formulate Alternatives

All alternatives are based on the following assumptions:

This stand, while not currently Kirtland's warbler habitat, has a DFC of potential Kirtland's warbler nesting habitat.

Even-aged management is the appropriate silvicultural system for jack pine.

Oak is a "neutral" species. It is not being favored nor discriminated against due to current lack of knowledge of it's relevance to Kirtland's warbler nesting. It is expected to stump sprout in alternatives 2 through 7, and regenerate at numbers similar to those that currently exist. That is less than the 20 percent that Kirtland's warbler's will tolerate (Probst 1987).

Whole tree harvesters and "shortwooders" are bidding the same rates.

Rotation length is fifty years.

The alternatives fall into two broad categories which are divided into more specific treatments as illustrated below:

	Alternative
Natural Regeneration	1. Minimum Level Management
	2. Clearcut / Prescribed fire.
	3. Clearcut / Rollerchop & scarify
Artificial Regeneration	4. Clearcut / Scarify & broadcast seed
	5. Clearcut / Scarify & direct seed
	6. Clearcut / Scarify & hand plant
	7. Clearcut / Machine plant

These alternatives were derived from the reforestation methods described earlier in this paper. Alternative 1 does not include any vegetative manipulation. All other alternatives are identified by the treatments which would follow clearcutting. For natural regeneration the logger would be required to leave cone bearing slash scattered across the site. Artificial regeneration methods would not require this, and in fact slash disposal would be an additional cost. For the purpose of this analysis, assume the artificial regeneration sites are whole tree harvested and no slash disposal costs are accrued.

Description of Alternatives

Alternative 1. Minimum Level Management

Under this alternative the only funding expenditures would be for silvexam and administrative activities. The jack pine in the stand will continue to deteriorate due to periodic jack pine budworm infestations. This will result in patches of jack pine regeneration that are highly susceptible to the next budworm infestation. The oak component would gradually become more pronounced

as seedlings and saplings currently in the understory replaced the jack pine. The recreation activities, hunting and camping, would remain largely unchanged over time. Wildlife use would gradually shift to species adapted to the higher availability of hardwoods for denning and mast. The fire hazard will be very high for the next 10 - 20 years due to the continuous jack pine mortality. If a wildfire occurs it will regenerate the stand to jack pine with an oak component as currently exists. This alternative would only result in creation of Kirtland's warbler habitat if a wildfire occurred prior to a significant loss of the jack pine seed source.

Alternative 2. Clearcut / Prescribed Fire

The site would be clearcut with cone bearing slash left scattered across the site. The site would then be broadcast burned to expose mineral soil, open the jack pine cones, and reduce the risk of wildfire. Oak would be expected to stump sprout and occur in numbers similar to what currently exist, and would be allowed to regenerate with the jack pine.

3. Clearcut / Rollerchop & scarify.

As in the second alternative conebearing slash would be left during clearcutting. Following harvest the slash will be chopped with a rollerchopper and scarified using anchor chains. This should be accomplished while the slash is still green, to insure proper scarification prior to the release of seed from the cones. This also gets the cones down close to the ground where they are more likely to open.

4. Clearcut / Scarify & broadcast seed.

This alternative would not require slash to be left on the site. Logging would consist of whole tree harvesting, as is the predominant practice in jack pine stands on the Huron N.F. Following harvest the site would be scarified using a disc or set of anchor chains and broadcast seeded. Seed would be applied at the rate of 8 ounces per acre

5. Clearcut / Scarify & direct seed.

This alternative would also involve whole tree harvesting. A modified corn planter or similar seeder would be used to direct seed the area. Seed would be applied at the rate of 4 to 6 ounces per acre directly into scalps or furrows created by the equipment.

6. Clearcut / Scarify & hand plant

After harvest the site would be patch scarified using a Bracke scarifier to scalp patches, followed by planting with contract hand planting crews.

7. Clearcut / Machine plant

This is the current practice on all sites managed for Kirtland's warbler habitat on the Huron-Manistee. Sites are whole tree harvested and machine planted at the rate of 1090 trees/acre.

Alternatives Eliminated from Detailed Analysis

Shelterwood system - this system of regenerating jack pine was not considered for several reasons: nonserotinous cones were lacking because fire history has favored serotinous cones; stocking is inadequate to carry three commercial

sales; the oak component would increase significantly; jack pine budworm in the residual timber could fall onto the seedlings in the understory.

Seed tree system - this was not considered due to the poor appearance of the trees (phenotype) and the poor site.

Prescribed burning of standing timber - this would duplicate the natural fires which regenerated this area historically, however the social acceptability is extremely low due to the risk of an escaped fire and the waste of timber resources. It is worth noting that this technique was implemented safely by the USFWS in May of 1992 under unique circumstances, i.e. large fuelbreaks all around and extremely well patrolled firelines.

Conversion to other species - conversion to red pine or oak could be accomplished on this site, but would not meet the DFC of potential Kirtland's warbler habitat.

Evaluation Criteria

There were two criteria used to compare alternatives and select a preferred alternative. The two criteria are regeneration risk and economics. These criteria were chosen because of the need to balance costs with relatively low risk procedures to create Kirtland's warbler habitat. Other criteria were considered for inclusion in this analysis, however weighting would have made them insignificant in relation to the criteria selected.

Regeneration Risk

Successful regeneration of jack pine is key to providing habitat for the Kirtland's warbler. A matrix was developed to rank the alternatives based on their ability to influence the factors affecting regeneration (Table 3). Since treatments are unable to influence precipitation, the ratings for this factor are based on susceptibility to drought. Soil fertility is rated based on short term release of nutrients following treatment.

	ALTERNATIVES						
FACTORS	1	2	3	4	5	6	7
Adequate seed/seedlings	-5	+5	+5	+2	+5	+5	+5
Suitable seedbed prep	-5	0	+2	+1	+5	+5	+5
Temperature (surface)	+5	-5	+2	+2	-1	+1	-1
Drought susceptibility (Precipitation)	+5	-3	-3	-3	0	+4	+4
Soil fertility (short term)	0	+5	+4	+2	-1	+1	-1
Competing vegetation	-5	+1	+2	+1	+5	+5	+5
TOTAL	-5	3	12	5	13	21	17
RANK	7	6	4	5	3	1	2

Table 3. Ratings and Ranking of Alternatives based on Regeneration Risk

Ratings for adequate seed/seedlings were based on either quantity or quality of available seeds or seedlings. Alternative 1 does not give the serotinous cones proper conditions to open and does not involve planting of seedlings, therefore it rates extremely low for this factor. Alternatives 2 and 3 rate very high due to the large quantity of seed available in the conebearing slash left after logging. Both treatments would result in cones opening and good seed dispersal. Alternative 4 rated lower relative to these because the amount of

seed provided by seeding is significantly less than that found in logging slash. Alternative 5 was higher than 4 because the seed used, while less in quantity, would be more efficiently dispersed and have better soil contact. Alternatives 6 and 7 rated very high because of the two or three years of seedling development prior to outplanting.

Seedbed preparation was rated based on an alternatives ability to expose mineral soil. The best soil exposure is created with the V-plows used in alternatives 5 and 7, and the Bracke scarifier used in alternative 6. The anchor chains used in alternatives 3 and 4 also do a very good job of exposing soil, but not to the same degree as the V-plows. Soil exposure by prescribed fire is frequently not adequate (Cooley 1972), therefore alternative 2 was rated 0. The Minimum Level Management option was rated -5 due to complete lack of any soil exposure.

Soil surface temperature was rated depending upon how well an alternative sheltered seedlings from exposure to drying by sun and wind. Alternative 1 rated high because of the shading from residual timber and brush. Alternative 2 rated very low because of the heat absorption of the black ash created by burning (Coffin 1984). Scarification done with anchor chains, particularly after rollerchopping slash, would create microsites sheltered from the elements where soil is ripped up and rutted. Therefore alternatives 3 and 4 received positive ratings. Alternatives 5 and 7 received slightly negative ratings because of the exposed nature of the furrow in which the trees are seeded or planted. Alternative 6 rated slightly positive because of the sheltered nature of the scalp.

Drought susceptibility ratings were based primarily on the ability of a young plant to withstand a prolonged period of drought during the first five years of stand establishment. Alternative 1 rated highest due to the moderate conditions experienced in the understory of an established stand. Alternatives 2 through 4 all received negative ratings due to the high mortality experienced by new seedlings during drought periods. Alternatives 6 and 7 were rated high because of the use of 2 year old seedlings with developed shoots and root systems.

Soil fertility was rated based on understanding of short term effects of each treatment. Alternative 1 would have no effect. Alternative 2 would release the most nutrients as the result of burning. Alternatives 3 and 4 would have short term positive effects due to the release of nitrogen and other nutrients from the stirring of the organic matter. Alternatives 5 and 7 were rated negative because of the removal of the topsoil for scalping of the furrows. 6 was rated slightly positive because the topsoil removed from the scalp is flipped over and the seedling is planted immediately adjacent to the mounded topsoil.

Competing vegetation is set back in all alternatives except Minimum Level Management. Scalping with the V-plow and Bracke scarifier removes sod for approximately 18" around the seedling, reducing competition for 3 - 5 years in nearly all situations. Therefore Alternatives 5 - 7 all rated +5's. Rollerchopping and dragging anchor chains is similarly effective and therefore Alternative 3 rated nearly as high. Dragging chains without the rollerchopping does not rip up the large chunks of sod, and is therefore effective for a

shorter period, about 1-3 years, thus alternative 4 rated slightly lower than alternative 3.

Economics

The Lake States TWIGS program was used for the economic analysis and comparison of the seven alternatives. Appendix L lists the Diary of Cost and Revenue Activities for each alternative. Appendix M shows the Investment Performance Analysis for each alternative. Revenues are based on the stumpage rates listed on the Transaction Evidence Appraisal Schedule No. 93-4, in the Timber Appraisal Handbook, FSH 2409.22 (Appendix N). A real discount rate of 4 % and a stumpage price inflation rate of 1.50% were used for all alternatives. Several assumptions were made that may not necessarily hold true in actual practice: 1) each alternative regenerated jack pine at stocking levels required for Kirtland's warbler habitat; 2) there was no difference in bid prices due to difference in harvesting methods, i.e. revenues generated, between whole tree harvesting and short wood harvesting are equal. 3) an investment length of 51 years was used.

Several evaluation criteria are commonly used to determine the most economically desirable alternative. For the purpose of this analysis I have used the Net Present Value (NPV) as the criteria to rank alternatives. It allows ranking of the alternatives directly by financial yield, the highest yield being the most desirable alternative. Table 4 lists the NPV and ranks the alternatives accordingly.

	ALTERNATIVE						
	1	2	3	4	5	6	7
NPV	-7.09	82.79	35.17	52.83	41.92	-110.01	-79.98
RANK	5	1	4	2	3	7	6

Table 4. Net Present Value (NPV) and Ranking of Alternatives.

Other evaluation criteria were generated by TWIGS, but were not used as for the following reasons: Equivalent Annual Income (EAI) is calculated using the NPV, therefore it yields the same result when comparing alternatives; Benefit cost ratio (B/C) could not be calculated for alternative 1, because it did not generate any revenues; Internal Rate of Return (IRR) was not be used because it was either not calculated or multiple IRR's were calculated; Soil Expectation Value (SEV) was not appropriate because there was standing timber on the site at the beginning of the analysis; Payback period, or years to pay back at discount, was 0 years for the six alternatives that required investments.

Decision Matrix

A decision matrix was developed to compare the alternatives. Scaled magnitudes were developed using the "Z" score scaling technique. These were added together to select an alternative. The criteria were not weighted, or you could say they where each given a weight of one (Canham 1990), to select the alternative. For comparison purposes two additional scenarios are presented which would reflect a shift in priorities to either a high emphasis on regeneration risk or a high emphasis on economics. In the first case regeneration risk is given a weight of two compared to a weight of one for economics. In the second scenario that is reversed. Z score calculations for the decision matrix are presented in Appendix O.

		Weights x scaled magnitudes by Alternative						
Criteria	Weights	1	2	3	4	5	6	7
Regen Risk	1	-2.45	-1.23	0.15	-0.92	0.31	1.53	0.92
Economics (NPV)	1	-0.13	1.12	0.46	0.70	0.55	-1.56	-1.14
Sum		-2.58	-0.11	0.61	-0.22	0.86	-0.03	-0.22
Rank		7	4	2	5	1	3	5
		Weight Set #2						
Regen Risk	2	-4.90	-2.46	0.30	-1.84	0.62	3.06	1.84
Economics (NPV)	1	-0.13	1.12	0.46	0.70	0.55	-1.56	-1.14
Sum		-5.03	-1.34	0.76	-1.14	1.17	1.50	0.70
Rank		7	6	3	5	2	1	4
		Weight Set #3						
Regen Risk	1	-2.45	-1.23	0.15	-0.92	0.31	1.53	0.92
Economics (NPV)	2	-0.26	2.24	0.92	1.40	1.10	-3.12	-2.28
Sum		-2.71	1.01	0.77	0.48	0.79	-1.59	-1.36
Rank		7	1	3	4	2	6	5

Table 5. Decision Matrix with Scaled Magnitudes and Rankings

Alternative Selected

As shown in the decision matrix the highest ranking alternative would be 5, the direct seeding alternative. Even in the weighted sums this alternative still ranks second in either scenario. These rankings are evidence of the fact that this alternative is strong with regard to both evaluation criteria, whether balanced or weighted. Therefore, the selected alternative for this stand is to clearcut and regenerate by direct seeding.

NEEDED RESEARCH

The Forest Plan identifies research needed with regard to silvicultural systems for jack pine, Kirtland's warbler habitat requirements, and the effects of whole tree harvesting on nutrient poor sands.

A significant amount of research has been done on silvicultural systems of jack pine for the production of wood products. More research is needed on the overall effect of these systems on various plant and animal communities within the jack pine ecosystem.

The Kirtland's warblers' habitat requirements are studied on a continuing basis by a number of different groups and individuals representing universities, government agencies, and privately funded organizations. The Kirtland's Warbler Recovery Team is kept informed of new discoveries so that these can be incorporated into management activities.

Whole tree harvesting is the only method of harvesting currently taking place in areas that are being managed for Kirtland's Warbler on the Huron National Forest. Little research, if any, exists which addresses the affects of this on the Grayling sands and the jack pine ecosystem on which the Kirtland's Warbler depends. As mentioned earlier, this is an area of needed research identified in the Forest Plan.

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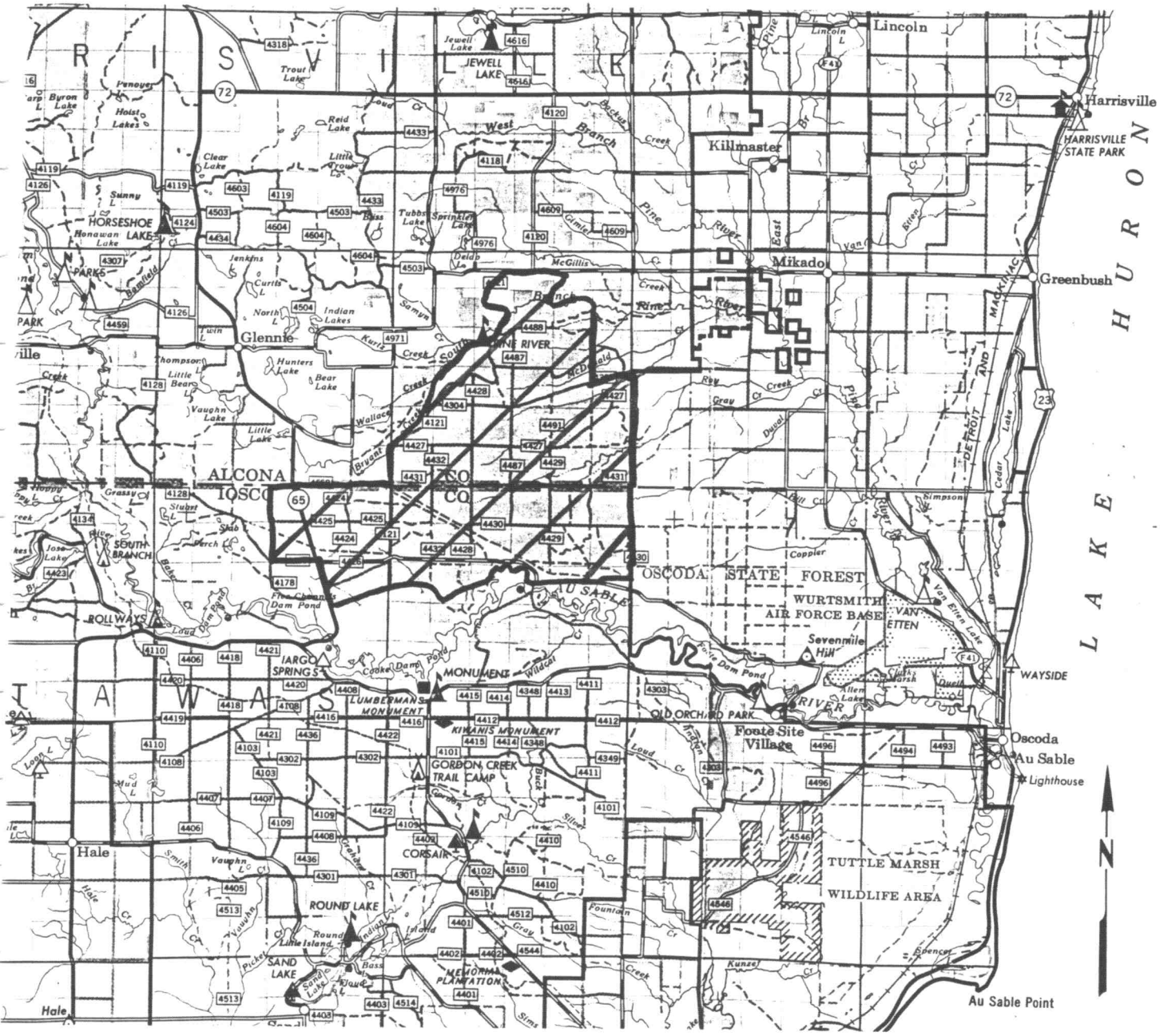
APPENDIX A

Vicinity Map

Scale: 1 inch = 4 miles



Pine River Opportunity Area

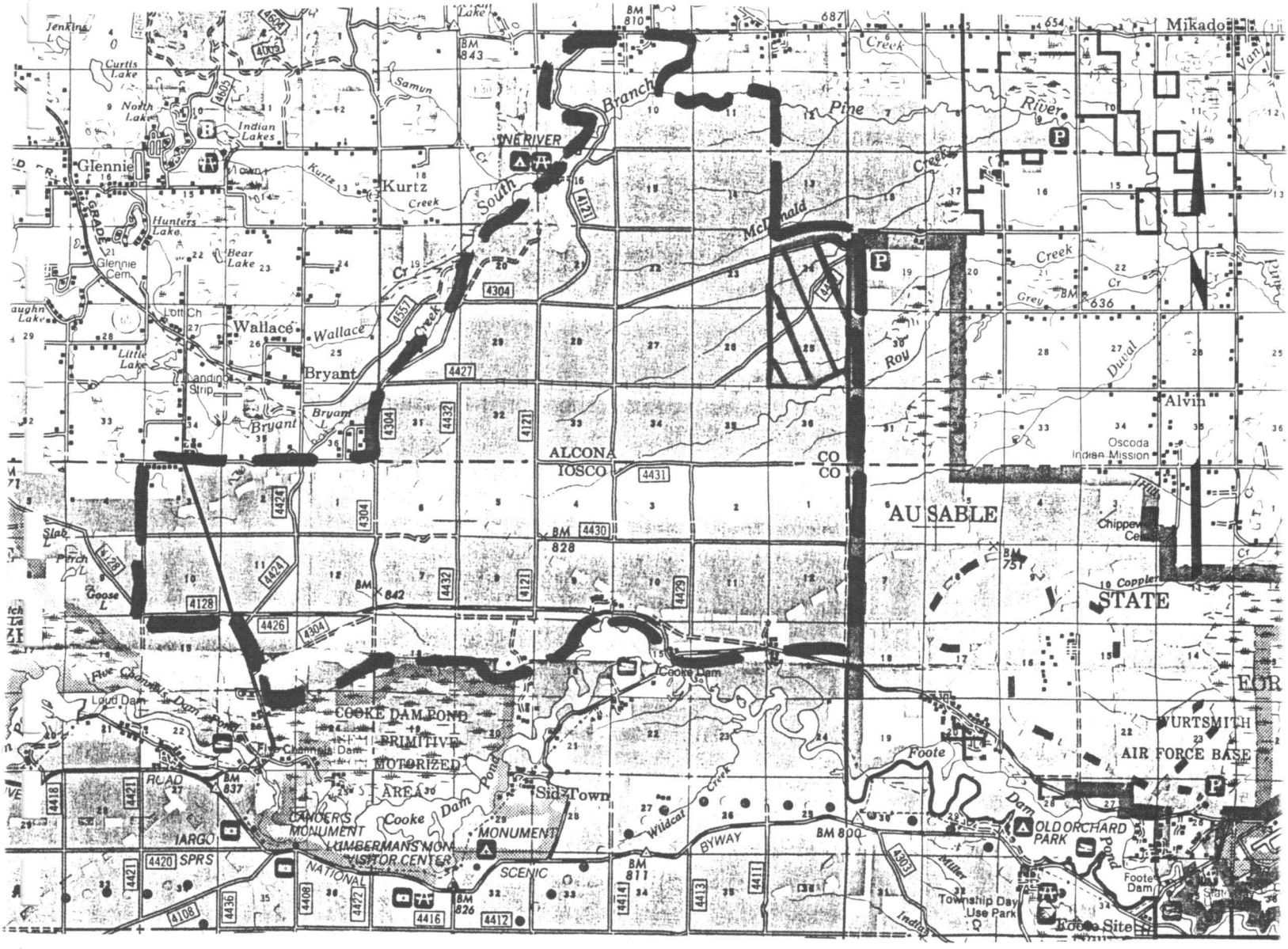
Harrisville Ranger District

Huron-Manistee National Forest

APPENDIX B

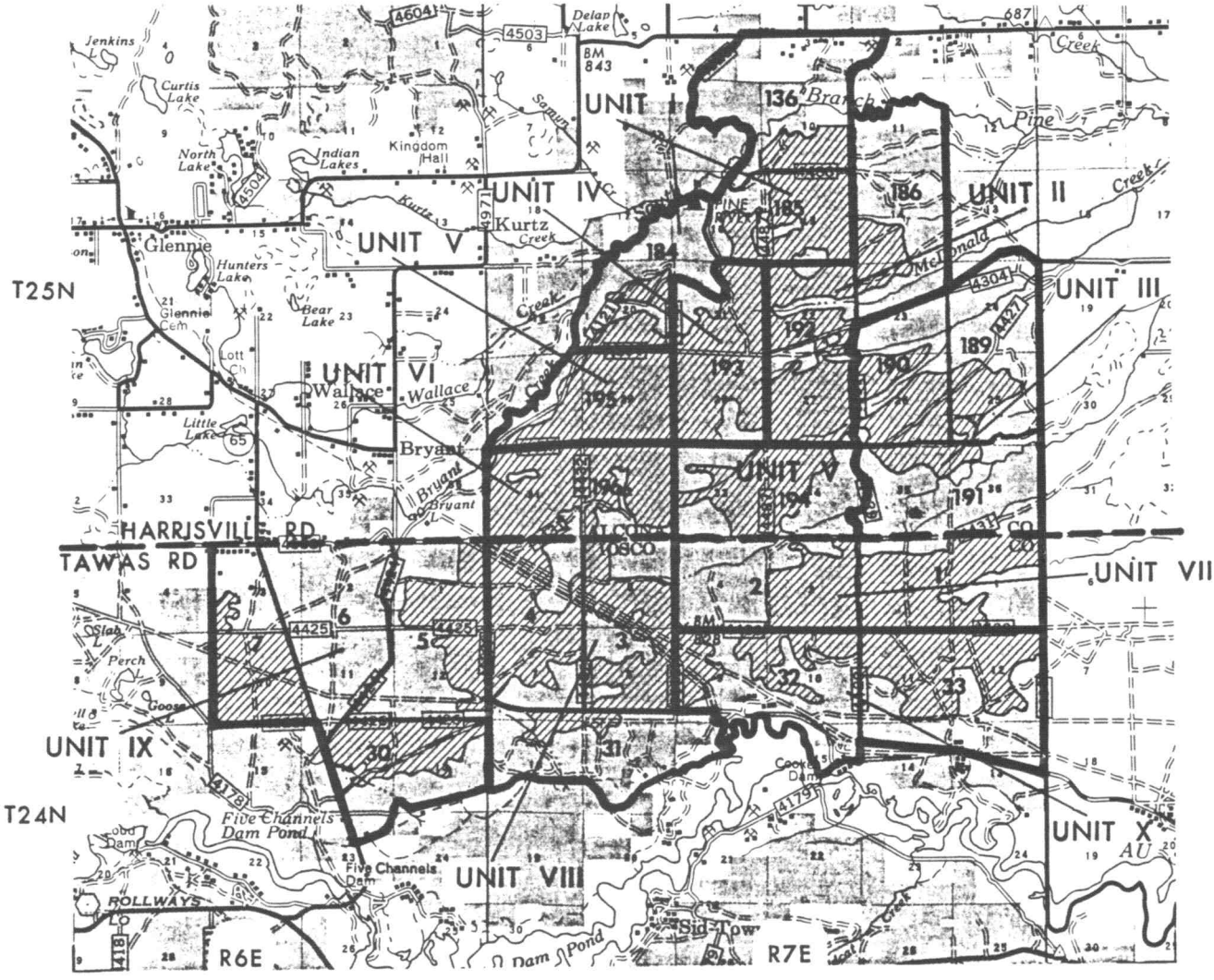
Pine River Opportunity Area Map

Scale: 1/2 inch = 1 mile



APPENDIX C

Map of Pine River Kirtland's Warbler Management Area



LEGEND

- UNIT BOUNDARY
- COMPARTMENT BOUNDARY
- RANGER DISTRICT BOUNDARY
- CRITICAL HABITAT IN NATIONAL FOREST OWNERSHIP
- CRITICAL HABITAT IN PRIVATE OWNERSHIP

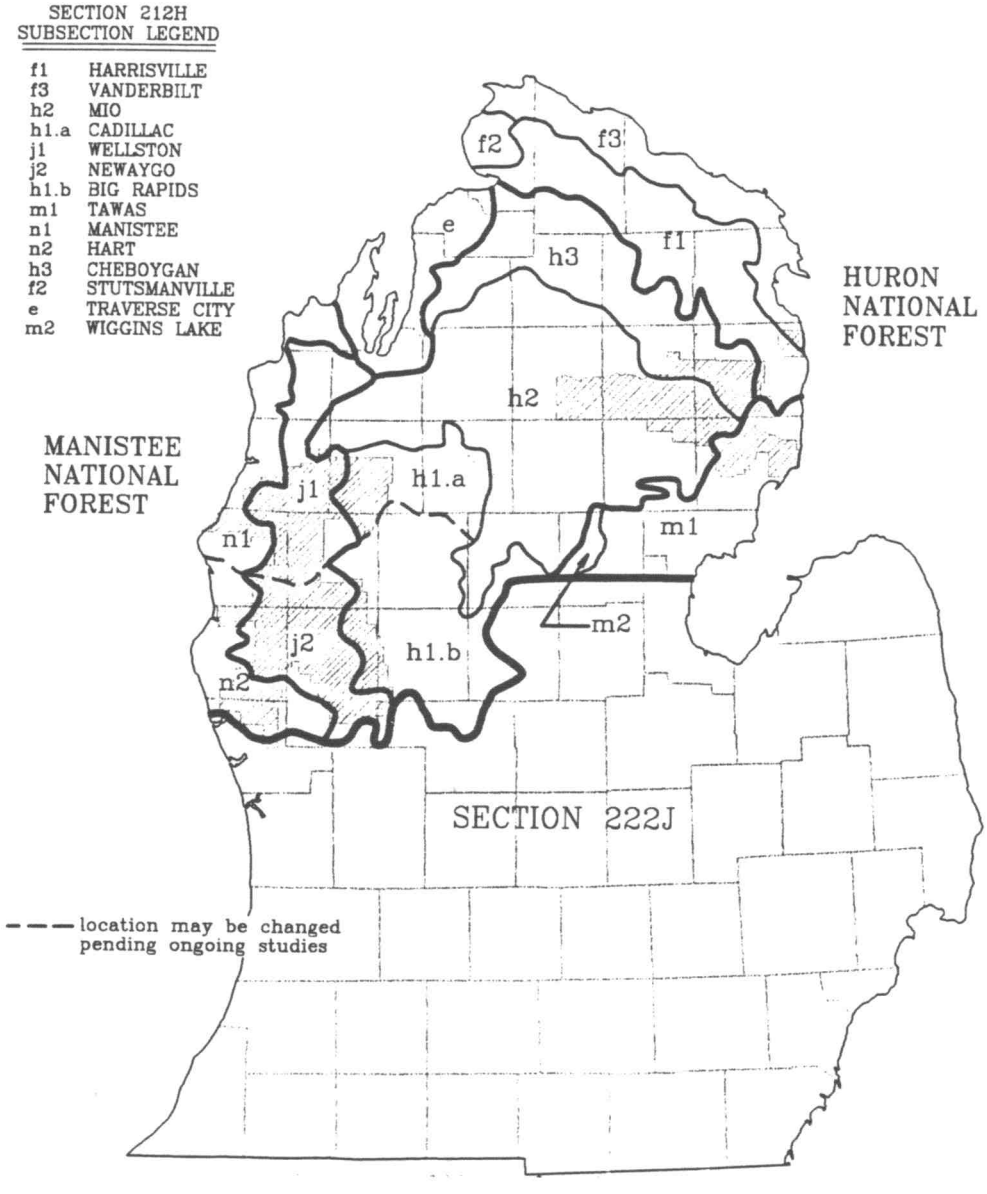
N

SCALE 1/2"=1 MILE

Source: USDI 1976

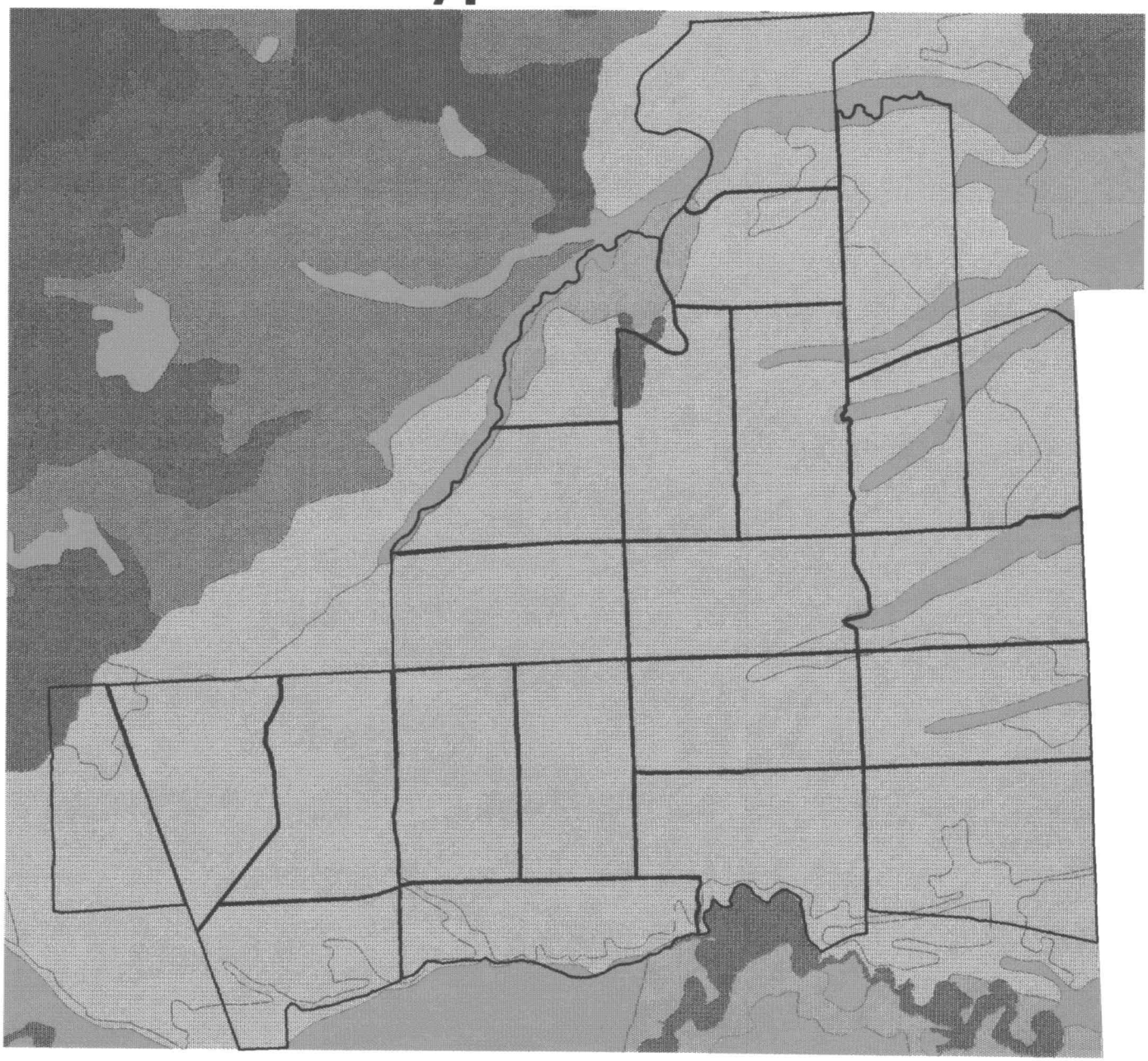
APPENDIX D

SUBSECTION MAP OF
HURON–MANISTEE NATIONAL FORESTS
SECTION 212H



Source: USDA 1993

Pine River KWMA
Land Type Associations



PINE

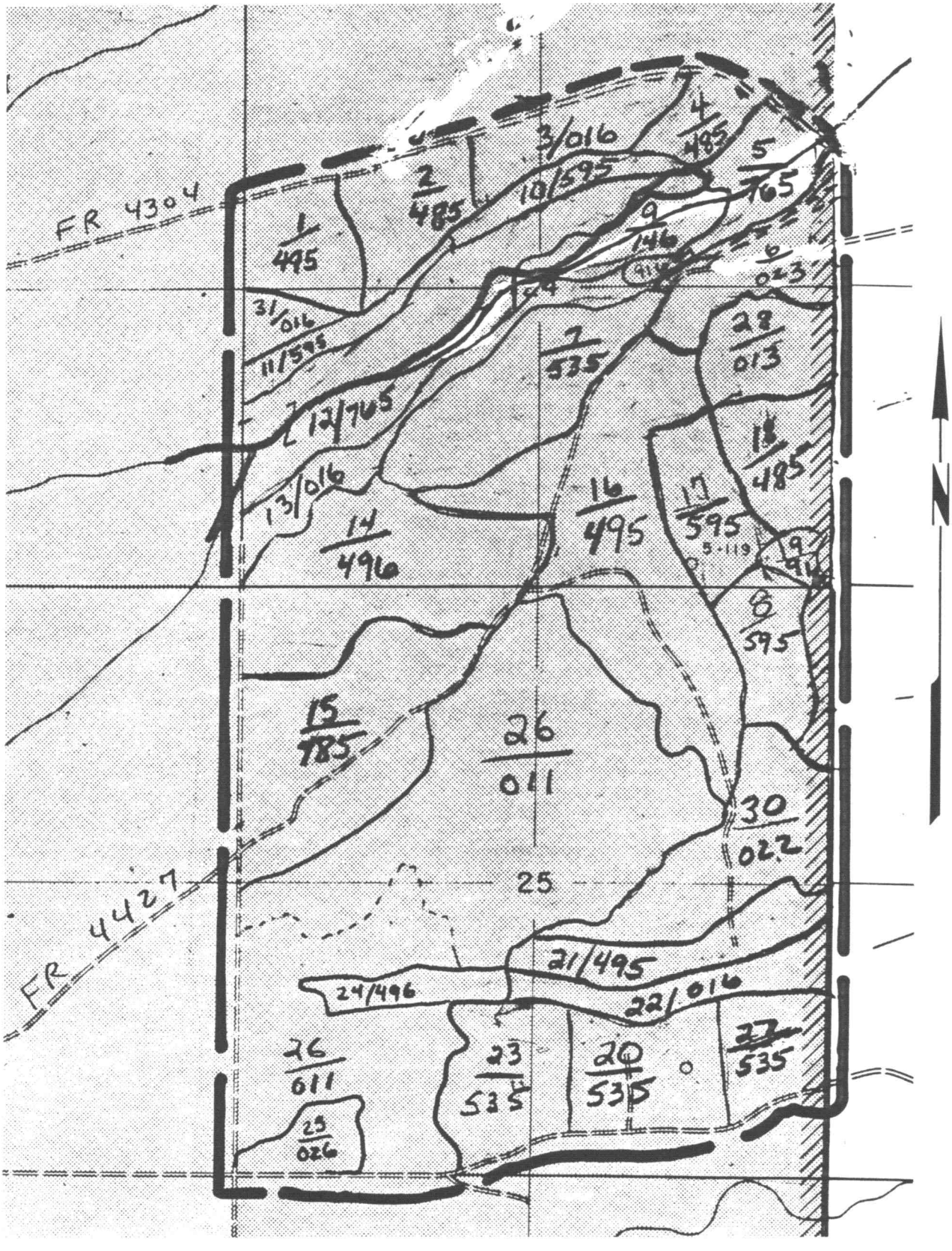
LTA

- Water
- Dry Outwash Sand Plains
- Sandy Ice-Contact/Morainal Hills
- Sandy Morainal Hills
- Wet Sand/Lake Plains
- Alluvial, Fluvial, Oranic Areas
- Clayey Hills and Plains

APPENDIX F

Compartment 189

Scale: 4 inches = 1 mile



APPENDIX G

USDA-Forest Service — STAND TALLY SHEET (CDS)

Forest 04 District 01 Comp. No. 189 Stand No. 003 Prescriber Quent McNichols

Stand Acres	020	TSI BA	—	Site Species	105	Veg Type	— — —	LTA	1
LSC	500	Slope %	00	Site Index	48	E/U	E	M.A.	45
Type Survey	933	Stocking %	— — —	Yr.Orig	1920	Supercanopy	—	M.A. Sub	— —
Surv.Yr.	9308	Operab	3	Spec Obj	105	Plot 2	Plot #4	O.A.	10
				SI Obj	48	105	105	VQO	MM
				SI Reliab	1	YOR 1923	YOR 1917		
						Tot Hight 54'	Height 63'		
						SI = 43	SI = 52		

Plot	TSD	Tot BA	Std Cond	MO	FS Typ Obj	DBH	Dmg Typ	Dmg Agt	Dmg %	Over Stry Ht	Undr Stry Ht	Over Stry Cc	Undr Stry Cc	Forbs Grnd Cover	Field Notes
1	016	90	4	6	48	09	8	2	80						Large number of Gypsy Moths - dead branches
2	016	70	1	6	01	08	9	2	10	54'					IP Budworm mortality
3	015	30	1	6	01	06	9	2	10						IP Budworm Mortality - oak in understory
4	016	110	4	6	01	08	8	2	50	63'					Oak partially defoliated
5	486	80	4	6	48	08									Oak sapl in given tree cap - scattered WP
Stand Summary															
	016	76	4	6	01	7									

PLOT DATA

Plt No.	Ln #	No. Trees	C/R	Spec.	DBH	AU DM CXW
01		01		105	04	D
01		01		809	10	
01		01		105	12	
01		05		105	10	
01		01		809	06	
01		01		105	08	

10

Plt No.	Ln #	No. Trees	C/R	Spec.	DBH	AU DM CXW
02		01		105	06	
02		05		105	08	
02		02		105	08	D
02		01		837	08	

9

Plt No.	Ln #	No. Trees	C/R	Spec.	DBH	AU DM CXW
03		02		105	08	
03		01		105	08	D
03		01		105	06	D
03		01		105	10	

5

Additional data for plots available on back of form

REMARKS: Plot #1 - Dead branches on oak due to repeated Gypsy moth def. " " " or IP " " budworm Mortality

Plot #2 - IP mortality due to budworm - Gypsy moth def. on Oak

" 3 " " " " " " " " " "

" 4 IP Mort light

5 " " mod - branch Mortality

Oak in understory ~ 2-3" saps-1 sap

802 = white Oak

809 = No. Red Oak

APPENDIX G (continued)

Stand Tally Sheet - page 2

PLOT DATA (Continued)

Plt No.	Ln #	No. Trees	C/R	Spec.	DBH	AU DM CXW
04		01		809	08	
4		05		105	06	
4		05		105	08	

Plt No.	Ln #	No. Trees	C/R	Spec.	DBH	AU DM CXW
05		01		105	12	
5		02		105	04	
5		02		809	06	
5		02		105	10	
5		01		809	04	

Plt No.	Ln #	No. Trees	C/R	Spec.	DBH	AU DM CXW

ACTIVITY INVENTORY

Act	Sched FY	Stim Act	Quantity
113	1993	032	020
411	1994	113	020
035	1995	411	020
035	1997	035	020
---	-----	---	---
---	-----	---	---
---	-----	---	---
---	-----	---	---
---	-----	---	---
---	-----	---	---
---	-----	---	---
---	-----	---	---

SPECIAL MNGMNT CONCERNS

Special Mgt. Concern	Description (not stored)

WITHIN STAND FEATURES

Feature	How Many	Description (not stored)
---	---	
---	---	
---	---	
---	---	
---	---	
---	---	
---	---	
---	---	
---	---	
---	---	

APPENDIX H

Tree list from Stand Tally Sheet (as summarized by TREEGEN)

```
Welcome to the wonderful world of ---
 TTTTT  W    W   III   GGGG  SSSS        The
   T    W    W    I    G     S          Woodsman's
   T    W WW W    I    G GG  SSSS       Ideal
   T    WW  WW    I    G  G     S       Growth projection
   T    W    W   III   GGGG  SSSS       System

The Data General version of STEMS
LAKE STATES VERSION 3.0.  DECEMBER 1987.


Please report any problems or peculiarities noted when
running the program to: "TWIGS", NCFES, 1992 FOLWELL AVE.,
ST. PAUL MN  55108.  PHONE: (612) 649-5173 OR FTS 777-5173
```

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
::                                                                          ::
::  Tree List File is C189_STD3                                             ::
::                                                                          ::
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
```

```
  13 Trees will be read for property "COMPARTMENT 189 ", stand "3       "
year= 1993, age= 73, site index for JACK PINE   = 48.0, plantation= 0
```

Seq num	Stems code	USFS code	Stems grp name	Dbh	Crown ratio	Trees/ac	Tree status	Tree class
1	1	105	JACK PINE	4.0	.0	22.9	3	40
2	1	105	JACK PINE	4.0	.0	45.8	1	20
3	1	105	JACK PINE	6.0	.0	10.2	3	40
4	1	105	JACK PINE	6.0	.0	61.1	1	20
5	1	105	JACK PINE	8.0	.0	17.2	3	40
6	1	105	JACK PINE	8.0	.0	74.5	1	20
7	1	105	JACK PINE	10.0	.0	29.3	1	20
8	1	105	JACK PINE	12.0	.0	5.1	1	20
9	22	809	O.RED OAK	4.0	.0	22.9	1	20
10	22	809	O.RED OAK	6.0	.0	30.6	1	20
11	22	809	O.RED OAK	8.0	.0	5.7	1	20
12	22	809	O.RED OAK	10.0	.0	3.7	1	20
13	22	837	O.RED OAK	8.0	.0	5.7	1	20

Tree list has 13 trees, tpa= 284.4, batot= 76.0, $\overline{\text{dbh}}$= 6.7

APPENDIX I

Economically Important Insects Associated with Jack Pine in Wisconsin

Insect Species	Tree Size Category				
	Seedlings	Saplings	Poles	Sawlogs	Seeds-Cones
White grubs - *Phyllophaga* spp.	X				
Grasshoppers - *Melanoplus* spp.	X				
Pine webworm - *Tetralopha robustella* Zeller	X				
Aphids - *Cinara* spp.	X				
Pine tortoise scale - *Toumeyella parvicornis* (Cock.)	X	X	X		
Pales weevil - *Hylobius pales* Herbst.	X	X			
Pine root collar weevil - *H. radicis* Buch.		X			
Pine root tip weevil - *H. rhizophagus* Millers		X	X		
White pine weevil - *Pissodes strobi* Peck.		X			
Eastern pine shoot borer - *Eucosma gloriola* Heinr.		X			
Saratoga spittlebug - *Aphrophora saratogensis* Fitch		X			
Pine spittlebug - *A. parallela* (Say)		X	X		
Pine chafer - *Anomala obivia* Horn.		X			
Red-headed pine sawfly - *Neodiprion lecontei* (Fitch)		X			
Red-headed jack pine sawfly - *N. rugifrons* Midd.		X			
Red-pine sawfly - *N. nanulus nanulus* Schedl		X	X		
Swaine jack pine sawfly - *N. swainei* Midd.		X	X		
European pine sawfly - *N. sertifer* (Geoffr.)		X	X		
Jack pine budworm - *Choristoneura pinus pinus* Freem.			X	X	X
Pine tussock moth - *Dasychira pinicola* (Dyar)			X	X	
Pine engraver - *Ips pini* Say			X	X	
Pine sawyer - *Monochamus notatus* (Drury)				X	
Red turpentine beetle - *Dendroctonus valens* LeConte				X	
Jack pine seed bug - *Platylygus luridus* Reut.					X
Red pine cone beetle - *Conophthorus resinosae* Hopk.					X
Pine cone midge - *Asynapta hopkinsi* (Felt)					X
Webbing coneworm - *Dioryctria disclusa* Heinr.					X
Shield backed pine seedbug - *Tetyra bipunctata* (Heinr. & Schaf.)					X
Eastern pine seed worm - *Laspeyresia toreuta* (Grote)					X
Red pine cone borer - *Eucosma monitorana* Heinr.					X

Source: Benjamin 1984

APPENDIX J

JACK PINE BUDWORM

Hazard Guide

Start with a value of zero and then add or subtract the guide values according to the attributes of the jack pine stand being examined.

Value	Attribute
+5	Current moderate to heavy budworm defoliation
+5	Staminate flowers abundant
+4	Low stocking (<100 ft^2/acre BA)
+3	Wolf trees present
+2	Suppressed jack pine present
+1	Trees over 40 years, slow growing, lacking vigor
-1	Rapid growing, vigorous trees
-2	Very few, or no, suppressed jack pine
-3	Uniformly sized, well crowned (50% live crown) trees
-4	Well stocked stand (>120 ft^2/acre BA)
-5	Male staminate flowers lacking or very few
-5	No, or very light, current budworm defoliation

If the stand sum is:

+17 to +20	HIGH risk. Expect a salvage operation, Priority 1
+11 to +16	HIGH risk. Priority 2 for salvage
+5 to +10	MODERATE risk. Probable low tree mortality rate
-10 to +4	LOW-MODERATE risk. Tree kill by budworm is unlikely
-20 to -11	LOW risk. Look elsewhere for problems

Developed by: Robert P. Ford
Entomologist
October, 1981

Source: Ford 1981

APPENDIX K

S T A N D C O N D I T I O N S F O R 1993

(INITIAL CONDITIONS)

Report for stand "3 ". Year= 1993. INITIAL CONDITIONS.
Age= 73, Cycle= 0, Site index for JACK PINE = 48.0

Species gr.	Live tree/ac	Ba/ acre	Avg dbh	Avg cai	Cut Tree/ac	Cut Ba/ac	Mortality Tree/ac	Mortality Ba/ac	Group si
JACK PINE									48.0
.0- 4.9	46	4.0	4.0	.00	0	.0	0	.0	
5.0-10.9	165	54.0	7.6	.00	0	.0	0	.0	
11.0+	5	4.0	12.0	.00	0	.0	0	.0	
Group totals	216	62.0	7.0	.00	0	.0	0	.0	
O.RED OAK									41.7
.0- 4.9	23	2.0	4.0	.00	0	.0	0	.0	
5.0-10.9	46	12.0	6.8	.00	0	.0	0	.0	
11.0+	0	.0	.0	.00	0	.0	0	.0	
Group totals	69	14.0	5.9	.00	0	.0	0	.0	
All species									
.0- 4.9	69	6.0	4.0	.00	0	.0	0	.0	
5.0-10.9	211	66.0	7.4	.00	0	.0	0	.0	
11.0+	5	4.0	12.0	.00	0	.0	0	.0	
Stand totals	284	76.0	6.7	.00	0	.0	0	.0	

cai = current annual diameter increment.

S t a n d V o l u m e

Species gr.	Sawtimber cuft	Sawtimber bdft	Pulpwood cuft	Pulpwood cords	Growing stock cuft	Residue cuft	Residue tons
JACK PINE	256	1559	574	7.3	830	548	13.1
O.RED OAK	0	0	180	2.3	180	133	4.1
Stand totals	256	1559	754	9.5	1010	681	17.2

Bdft volumes are in Int. 1/4.

mean annual increment = 13.8 cuft/year.

APPENDIX L

Diary of Cost and Revenue Activities for each Alternative

(as generated by TWIGS)

Alternative 1. Minimum Level Management

(ALL CASH FLOWS ARE IN BASE YEAR DOLLARS PER ACRE)

ENTRY	NAME	YEAR(S)	COST	REVENUE	INFLATION RATE
1	SILVEXAM	1993	3.00	.00	.00
		2003	3.00	.00	.00
		2013	3.00	.00	.00
		2023	3.00	.00	.00
		2033	3.00	.00	.00

Alternative 2. Clearcut / Prescribed Fire

(ALL CASH FLOWS ARE IN BASE YEAR DOLLARS PER ACRE)

ENTRY	NAME	YEAR(S)	COST	REVENUE	INFLATION RATE
1	SILVEXAM	1993	3.00	.00	.00
		2003	3.00	.00	.00
		2013	3.00	.00	.00
		2023	3.00	.00	.00
		2033	3.00	.00	.00
2	SALE PREP	1993	17.20	.00	.00
		2043	17.20	.00	.00
3	SALE ADMIN	1993	15.00	.00	.00
		2043	15.00	.00	.00
4	PRES. BURN	1994	35.00	.00	.00
5	STOCK. SURVY	1995	2.50	.00	.00
		1997	2.50	.00	.00
6	SALE INCOME	1993	.00	130.54	1.50
7	SALE INCOME	2043	.00	174.34	1.50

APPENDIX L (continued)

Diary of Cost and Revenue Activities for each Alternative

Alternative 3. Clearcut / Rollerchop & scarify

(ALL CASH FLOWS ARE IN BASE YEAR DOLLARS PER ACRE)

ENTRY	NAME	YEAR(S)	COST	REVENUE	INFLATION RATE
1	SILVEXAM	1993	3.00	.00	.00
		2003	3.00	.00	.00
		2013	3.00	.00	.00
		2023	3.00	.00	.00
		2033	3.00	.00	.00
2	SALE PREP	1993	17.20	.00	.00
		2043	17.20	.00	.00
3	SALE ADMIN	1993	15.00	.00	.00
		2043	15.00	.00	.00
4	ROLLER CHOP	1994	60.00	.00	.00
5	DRAG CHAINS	1994	25.00	.00	.00
6	STOCK SURVY	1995	2.50	.00	.00
		1997	2.50	.00	.00
7	SALE INCOME	1993	.00	130.54	1.50
8	SALE INCOME	2043	.00	174.34	1.50

Alternative 4. Clearcut / Scarify & broadcast seed

(ALL CASH FLOWS ARE IN BASE YEAR DOLLARS PER ACRE)

ENTRY	NAME	YEAR(S)	COST	REVENUE	INFLATION RATE
1	SILVEXAM	1993	3.00	.00	.00
		2003	3.00	.00	.00
		2013	3.00	.00	.00
		2023	3.00	.00	.00
		2033	3.00	.00	.00
2	SALE PREP	1993	17.20	.00	.00
		2043	17.20	.00	.00
3	SALE ADMIN	1993	15.00	.00	.00
		2043	15.00	.00	.00
4	DRAG CHAINS	1994	25.00	.00	.00
5	SEEDING	1995	6.25	.00	.00
6	SEED - 8 oz.	1995	37.50	.00	.00
7	STOCK SURVY	1996	2.50	.00	.00
		1998	2.50	.00	.00
8	SALE INCOME	1993	.00	130.54	1.50
9	SALE INCOME	2043	.00	174.34	1.50

APPENDIX L (continued)

Diary of Cost and Revenue Activities for each Alternative

Alternative 5. Clearcut / Scarify & direct seed

(ALL CASH FLOWS ARE IN BASE YEAR DOLLARS PER ACRE)

ENTRY	NAME	YEAR(S)	COST	REVENUE	INFLATION RATE
1	SILVEXAM	1993	3.00	.00	.00
		2003	3.00	.00	.00
		2013	3.00	.00	.00
		2023	3.00	.00	.00
		2033	3.00	.00	.00
2	SALE PREP	1993	17.20	.00	.00
		2043	17.20	.00	.00
3	SALE ADMIN	1993	15.00	.00	.00
		2043	15.00	.00	.00
4	DIRECT SEED	1994	50.00	.00	.00
5	SEED - 6 oz.	1994	28.12	.00	.00
6	STOCK SURVY	1996	2.50	.00	.00
		1998	2.50	.00	.00
7	SALE INCOME	1993	.00	130.54	1.50
8	SALE INCOME	2043	.00	174.34	1.50

Alternative 6. Clearcut / Scarify & hand plant

(ALL CASH FLOWS ARE IN BASE YEAR DOLLARS PER ACRE)

ENTRY	NAME	YEAR(S)	COST	REVENUE	INFLATION RATE
1	SILVEX	1993	3.00	.00	.00
		2003	3.00	.00	.00
		2013	3.00	.00	.00
		2023	3.00	.00	.00
		2033	3.00	.00	.00
2	SALE PREP	1993	17.20	.00	.00
		2043	17.20	.00	.00
3	SALE ADMIN	1993	15.00	.00	.00
		2043	15.00	.00	.00
4	BRACKE SCARI	1994	25.00	.00	.00
5	HAND PLANT	1995	60.00	.00	.00
6	SEEDLINGS	1995	163.50	.00	.00
7	STOCK SURVY	1997	2.50	.00	.00
		1999	2.50	.00	.00
8	SALE INCOME	1993	.00	130.54	1.50
9	SALE INCOME	2043	.00	174.34	1.50

APPENDIX L (continued)

Diary of Costs and Revenues for each Alternative

Alternative 7. Clearcut / Machine plant

(ALL CASH FLOWS ARE IN BASE YEAR DOLLARS PER ACRE)

ENTRY	NAME	YEAR(S)	COST	REVENUE	INFLATION RATE
1	SILVEXAM	1993	3.00	.00	.00
		2003	3.00	.00	.00
		2013	3.00	.00	.00
		2023	3.00	.00	.00
		2033	3.00	.00	.00
2	SALE PREP	1993	17.20	.00	.00
		2043	17.20	.00	.00
3	SALE ADMIN	1993	15.00	.00	.00
		2043	15.00	.00	.00
4	MACHINE PLAN	1995	52.93	.00	.00
5	SEEDLINGS	1995	163.50	.00	.00
6	STOCK SURVY	1996	2.50	.00	.00
		1998	2.50	.00	.00
7	SALE INCOME	1993	.00	130.54	1.50
8	SALE INCOME	2043	.00	174.34	1.50

APPENDIX M

Investment Performance Analysis for each Alternative

(as generated by TWIGS)

Alternative 1. Minimum Level Management

REAL DISCOUNT RATE = 5.00%
(INVESTMENT LENGTH = 51 YEARS)

(ALL MONETARY VALUES ARE IN BASE YEAR DOLLARS PER ACRE)

NET PRESENT VALUE (NPV)	$	-7.09
EQUIVALENT ANNUAL INCOME (EAI)	$	-.39
SOIL EXPECTATION VALUE (SEV)	$	-7.77
BENEFIT/COST RATIO		.00

NO PAYBACK WITHIN LIFE OF INVESTMENT (50 DISCOUNTING PERIODS)

NO REAL INTERNAL RATE OF RETURN CAN BE CALCULATED

Alternative 2. Clearcut / Prescribed fire

REAL DISCOUNT RATE = 5.00%
(INVESTMENT LENGTH = 51 YEARS)

(ALL MONETARY VALUES ARE IN BASE YEAR DOLLARS PER ACRE)

NET PRESENT VALUE (NPV)	$	82.79
EQUIVALENT ANNUAL INCOME (EAI)	$	4.53
SOIL EXPECTATION VALUE (SEV)	$	90.69
BENEFIT/COST RATIO		2.04
YEARS TO PAY BACK AT DISCOUNT		0 YEARS

NO REAL INTERNAL RATE OF RETURN CAN BE CALCULATED

APPENDIX M (continued)

Investment Performance Analysis for each Alternative

Alternative 3. Clearcut / Rollerchop & scarify

REAL DISCOUNT RATE = 5.00%
(INVESTMENT LENGTH = 51 YEARS)

(ALL MONETARY VALUES ARE IN BASE YEAR DOLLARS PER ACRE)

NET PRESENT VALUE (NPV)	$	35.17
EQUIVALENT ANNUAL INCOME (EAI)	$	1.93
SOIL EXPECTATION VALUE (SEV)	$	38.53
BENEFIT/COST RATIO		1.28
YEARS TO PAY BACK AT DISCOUNT		0 YEARS

TWO REAL INTERNAL RATES OF RETURN ARE NOT BETWEEN -40% AND +200%

Alternative 4. Clearcut / Scarify & broadcast seed

REAL DISCOUNT RATE = 5.00%
(INVESTMENT LENGTH = 51 YEARS)

(ALL MONETARY VALUES ARE IN BASE YEAR DOLLARS PER ACRE)

NET PRESENT VALUE (NPV)	$	52.83
EQUIVALENT ANNUAL INCOME (EAI)	$	2.89
SOIL EXPECTATION VALUE (SEV)	$	57.88
BENEFIT/COST RATIO		1.48
YEARS TO PAY BACK AT DISCOUNT		0 YEARS

NO REAL INTERNAL RATE OF RETURN CAN BE CALCULATED

APPENDIX M (continued)

Investment Performance Analysis for each Alternative

Alternative 5. Clearcut / Scarify & direct seed

REAL DISCOUNT RATE = 5.00%
(INVESTMENT LENGTH = 51 YEARS)

(ALL MONETARY VALUES ARE IN BASE YEAR DOLLARS PER ACRE)

NET PRESENT VALUE (NPV)	$ 41.92
EQUIVALENT ANNUAL INCOME (EAI)	$ 2.30
SOIL EXPECTATION VALUE (SEV)	$ 45.93
BENEFIT/COST RATIO	1.35
YEARS TO PAY BACK AT DISCOUNT	0 YEARS
NO REAL INTERNAL RATE OF RETURN CAN BE CALCULATED	

Alternative 6. Clearcut / Scarify & hand plant

REAL DISCOUNT RATE = 5.00%
(INVESTMENT LENGTH = 51 YEARS)

(ALL MONETARY VALUES ARE IN BASE YEAR DOLLARS PER ACRE)

NET PRESENT VALUE (NPV)	$ -110.01
EQUIVALENT ANNUAL INCOME (EAI)	$ -6.03
SOIL EXPECTATION VALUE (SEV)	$ -120.52
BENEFIT/COST RATIO	.60
YEARS TO PAY BACK AT DISCOUNT	0 YEARS
FIRST REAL INTERNAL RATE OF RETURN	1.49%
SECOND REAL INTERNAL RATE OF RETURN	67.22%

APPENDIX M (continued)

Investment Performance Analysis for each Alternative

Alternative 7. Clearcut / Machine plant

REAL DISCOUNT RATE = 5.00%
(INVESTMENT LENGTH = 51 YEARS)

(ALL MONETARY VALUES ARE IN BASE YEAR DOLLARS PER ACRE)

NET PRESENT VALUE (NPV)	$ -79.98
EQUIVALENT ANNUAL INCOME (EAI)	$ -4.38
SOIL EXPECTATION VALUE (SEV)	$ -87.62
BENEFIT/COST RATIO	.67
YEARS TO PAY BACK AT DISCOUNT	0 YEARS
FIRST REAL INTERNAL RATE OF RETURN	1.99%
SECOND REAL INTERNAL RATE OF RETURN	51.54%

Soil Expectation Value (SEV) is the capitalized value of an infinitely long series of cash flows associated with a timber management alternative that starts with BARE LAND. While a SEV was determined from the inputted cash flows, the calculated value is not appropriate for interpretation unless the base year for the analysis was set to the year of planting, all timber management cash flows were incorporated for the entire rotation, and all cash flows were in base year dollars. Land purchase costs and land sale returns must be removed from the cash flow stream before SEV is computed.

When multiple internal rates of return are calculated, the user should look at the profile of net present values for the project at various discount rates (the previous table) to make an appropriate selection.

APPENDIX N

Transaction Evidence

TRANSACTION EVIDENCE APPRAISAL SCHEDULE NO. 93-4 (3/92**3/93)
(Effective Dates: 08/01/93 - 10/30/93)

HURON NF (4 QUARTERS)

TIMBER APPRAISAL VALUES FOR THE
HURON-MANISTEE
NATIONAL FOREST
PROGRAM RUN 8-JUL-93
EFFECTIVE DATE 01-AUG-1993
BASE PERIOD: 4-92 TO 3-93

DISTRICTS 5, 6, 7

SPECIES	PRODUCT	UNITS	********** BASE PRICE	HAUL COST	********** SOLD VOLUME	NO-BID VOLUME
OTHER HARDWD	SAWTBR	MBF	43.39	.00	830.	0.
OTHER HARDWD	PULP	CDS	9.99	.00	10971.	0.
JACK PINE	SAWTBR	MBF	28.84	.00	2033.	0.
JACK PINE	PULP	CDS	8.64	.00	20786.	0.
RD & WT PINE	SAWTBR	MBF	56.93	.00	2859.	0.
RD & WT PINE	PULP	CDS	12.85	.00	18101.	0.
ASPEN	SAWTBR	MBF	35.06	.00	1616.	0.
ASPEN	PULP	CDS	12.32	.00	7561.	0.
RD & BL OAK	SAWTBR	MBF	98.12	.00	54.	0.

BASE PERIOD COSTS	$/CCF	$/CD	$/MBF	AVERAGE HAUL COSTS	$/CCF	$/CD	$/MBF
ROAD MAINT. COST	.00	.00	.00	SAWTIMBER	.00	.00	.00
CONTRACTUAL COST	.00	.00	.00	PULPWOOD	.00	.00	
TEMP. ROAD COST	1.51	1.19	2.51	POSTS	.00	.00	
OPT. COST 1	.00						
OPT. COST 2	.00						
OPT. COST 3	.00						

APPENDIX O

Z Score Calculations for the Decision Matrix

Scaled Magnitudes

$Z = \frac{(Xi-Xm)}{Sx}$

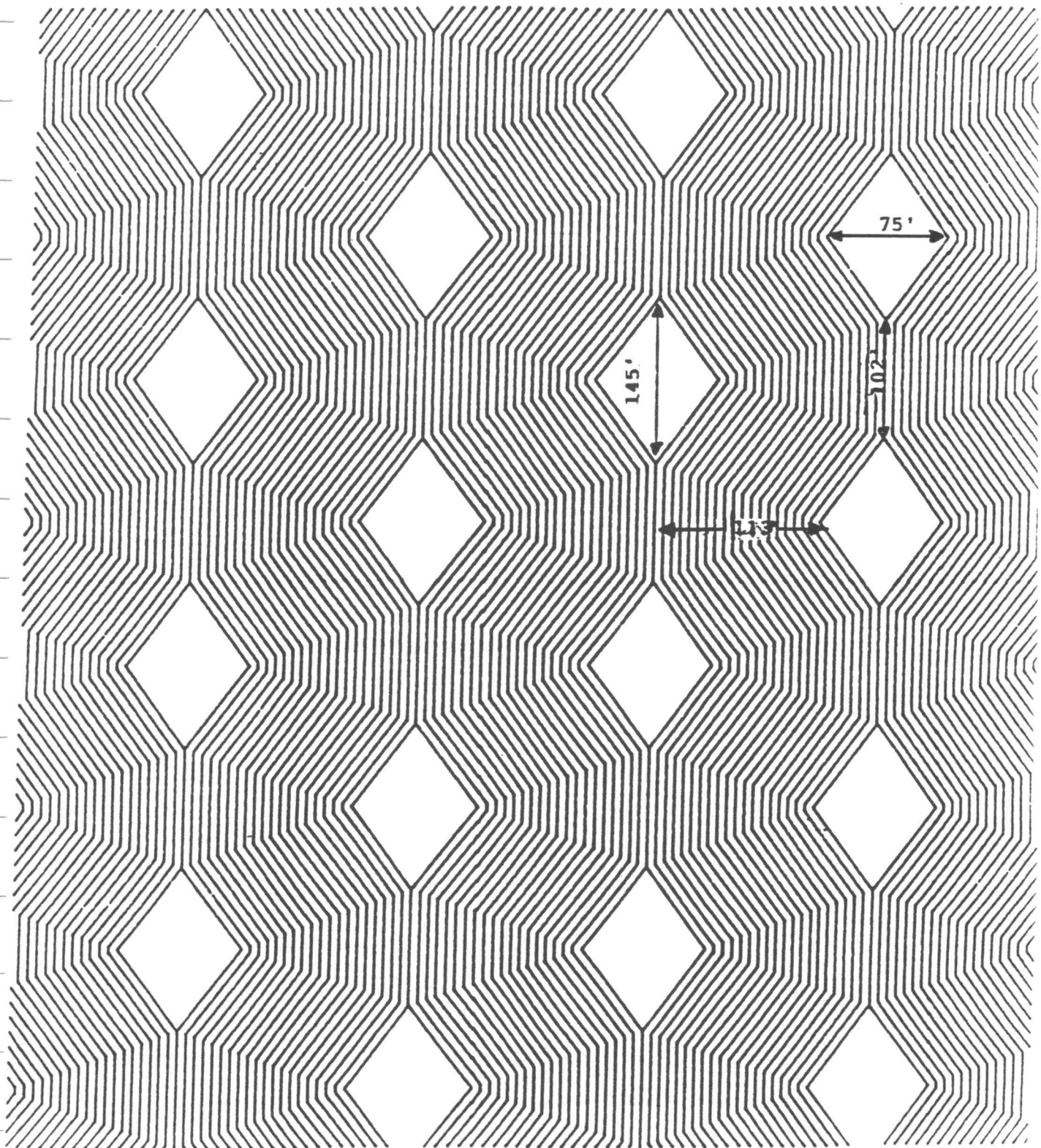
Where: Xi = data point
Xm = average of all points in data set
Sx = standard deviation of the data set

	ALTERNATIVE						
	Min Level	Prescribed Fire	Chop/ Scarify	Broad-cast Seed	Direct Seed	Hand Plant	Machine Plant
	1	2	3	4	5	6	7
Regeneration Risk							
$Z = \frac{(Xi-11)}{6.52}$							
Data Point	- 5	3	12	5	13	21	17
Unweighted (Z)	-2.45	-1.23	0.15	-0.92	0.31	1.53	0.92
Weighted (Zx2)	-4.90	-2.46	0.30	-1.84	0.62	3.06	1.84
Economics							
$Z = \frac{(Xi-2.23)}{72.05}$							
Data Point	-7.09	82.79	35.17	52.83	41.92	-110.01	-79.98
Unweighted (Z)	-0.13	1.12	0.46	0.70	0.55	- 1.56	- 1.14
Weighted (Zx2)	-0.26	2.24	0.92	1.40	1.10	- 3.12	- 2.28
Totals							
Unweighted Sums	-2.58	-0.11	0.61	-0.22	0.86	-0.03	-0.22
Rank	7	4	2	5	1	3	5
Weighted Sums (Regen Risk x 2)	-5.03	-1.34	.76	-1.14	1.17	1.50	0.7
Rank	7	6	3	5	2	1	4
Weighted Sums (Economics x 2)	-2.71	1.01	0.77	0.48	0.79	-1.59	-1.36
Rank	7	1	3	4	2	6	5

APPENDIX P

Machine Planting Pattern for KW Plantation

KIRTLAND'S WARBLER CONFIGURATION
OPPOSING WAVE PATTERN
TREE SPACING:
6 FEET BETWEEN ROWS
5 FEET BETWEEN TREES W/ROWS



APPENDIX Q

White Paper (draft) regarding use of herbicides in Region 9

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HERBICIDE EIS POSITION STATEMENT

On March 21, 1990 Lake States National Forest Supervisors elected not to continue preparation of Environmental Impact Statements (EISs) proposing use of herbicides. This agreement is intended to affect only National Forests in Minnesota, Wisconsin and Michigan and applies only to our efforts to develop EISs related to herbicide use on the national forests. It does not apply to the use insecticides, fungicides, rodenticides, and other chemicals that fall under the generic classification of pesticides. Associated with this agreement is a commitment to continue monitoring and evaluation of implementation of the Forest Plans and reconsider this strategy if monitoring reveals that National Forest goals and objectives cannot be met.

This agreement was reached after careful consideration of all the management concerns that we must address on the National Forests, primarily the high cost of developing the EISs, both in budget and personnel commitments. The Forest Supervisors believe that we can implement our Forest Plans without the use of herbicides and chose to concentrate on other high priority issues at this time. This is not expected to result in any need to amend Forest Plans.

As a result, most use of herbicides on the Lake States national forests will be suspended at this time. Seed orchards and nurseries are not affected by this decision. A separate analysis is being conducted regarding these activities. FSH 1909.15 (Environmental Policy and Procedures Handbook) identifies types of actions that may be categorically excluded from NEPA requirements. It also identifies categories of actions for which a project file and Decision Memo may be prepared in lieu of an EIS or Environmental Assessment (EA). Examples of exceptions for which the use of herbicides may be permitted include certain low-impact pest management activities, such as suppressing poisonous plants in campgrounds and picnic areas and certain low intensity research projects. There may also be certain easements where the right to utilize herbicides may have been conveyed in the easement and NEPA does not apply.

We recognize that this decision could affect permittees and other agencies who have planned to utilize herbicides to accomplish certain planned work on the National Forests. We will encourage them to utilize alternate methods but recognize that they may still wish to use herbicides. If so, they will be asked to prepare a Risk Assessment and an EIS. However, it is important that they must recognize that our agreeing to let them prepare the required NEPA documents does not convey implied approval.